WELLGREEN PROJECT OVERVIEW REPORT

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EXECUTIVE SUMMARY

Hudson-Yukon Mining Ltd. operated the Wellgreen mine for a short time, closing the operation in 1973. The adit to the underground workings lies in the upper Quill Creek drainage and the mill site is located adjacent to the Alaska Highway, near Quill Creek. Exploration of the property is currently underway and the present exploration camp is located between Arch and Nickel creeks. Preliminary concepts for the present project are for a relatively large scale open pit, reactivation of the existing underground workings, and milling on-site, but not at the former mill site. Preliminary plans are to dispose of tailings into two small lakes in the upper Arch Creek watershed. The mill may also be located in the upper Arch Creek valley.

Norecol Environmental Consultants Ltd. conducted environmental studies on the Wellgreen project in 1987 on behalf of a joint venture between Chevron Resources Canada Ltd. and All-North Resources Ltd. Field studies are ongoing in 1988 for All-North, the current project operator. Based on a review of existing information and a site inspection in July 1987, wildlife and fisheries were identified as the major environmental concerns for the project. Field studies were conducted in late August and late October, 1987 and continued in mid March 1988 to collect baseline environmental data. The components of the field investigations included hydrogeology, surface water hydrology, water quality, acid generation potential, fisheries and wildlife.

Hydrogeology studies indicate that the two major hydrogeological domains are the mountainous area (St. Elias Mountains) to the south and west and the flats north and east of the project area. The rock in the mountainous area is relatively impermeable to groundwater, but is overlain by a layer of more permeable talus. In the flats, permafrost probably limits flow to the upper few metres. To the east of the property the water table is a few tens of metres deep near the mountains and less than one metre deep near the Kluane River. Fluctuations in the groundwater table and interactions between the groundwater and surface water will effect the water balance of the small lakes in the tailings area.

Staff and crest gauges were installed in Nickel Creek and upper Arch Creek and stream flows were measured at these sites. Ongoing studies are required to generate a staff/discharge relationship for determining the hydrologic characteristics of the area.

The water sampling program for the Wellgreen project monitored fifteen surface water sites and five groundwater sites. Surface waters are generally alkaline and moderately to very hard. High levels of copper, nickel and selenium were found in Aird Creek and upper Arch Creek, and elevated levels of aluminum, copper and iron occurred in most drainages when suspended solids levels were elevated. The adit water is hard and highly conductive with high levels of nickel and selenium. Groundwater in the exploration area was alkaline with elevated levels of dissolved chromium and nickel.

Preliminary acid generation potential studies indicate that the ore may be acid producing but that the host rock is not. Additional sampling will be required to confirm these preliminary tests.

The fisheries resources of most concern are the chum salmon which spawn in the Kluane River near Quill Creek. Backwaters and sloughs in the river which are fed by upwelling groundwater have been identified as major chum salmon spawning areas. Quill Creek, Arch Creek and the Donjek River appear to have low fisheries values. If the tailings pond and mill are placed in the Arch Creek (Donjek River) drainage, then the potential impacts on fisheries would be significantly reduced.

Caribou and Dall's sheep occur in the project area along with smaller numbers of moose, grizzly bears and, occasionally, wolves and black bears. Dall's sheep appear to remain in the Mt. Wellgreen area and vicinity on a year round basis. Caribou belong to the Burwash herd, which has its main calving and rutting grounds to the south in the Burwash Uplands. There is some caribou wintering activity in the lower elevations of the Quill Creek valley, although the main winter ranges are to the south in the Burwash Uplands area and to the east in the Brooks Arm Plateaux.

Project development has potential to affect Dall's sheep and caribou populations and could have indirect effects on grizzly bears. Further documentation of the seasonal distribution and habitat relationships of the major wildlife species in the areas is recommended.

Additional environmental studies which will occur during the remainder of 1988 are described. These studies will include wildlife, fisheries, acid generation potential and hydrology.

The socio-economic considerations of the project are presented. The nearest communities to the project site are Burwash Landing (approximately 30 km), Destruction Bay (approximately 50 km) and Haines Junction (approximately 200 km). As the Alaska Highway is the major transportation corridor in the Yukon, communities beside it, particularly those close to Kluane National Park, have benefited from tourist traffic, which has increased over the years.

Whitehorse, Yukon's capital and largest city, is a rapidly growing centre with a population of approximately 19,200. Whitehorse is the major administrative, supply and tourist centre in the Yukon. The smaller communities nearer the project site, Haines Junction (population 584), Burwash Landing (95) and Destruction Bay (48) generally have limited services and housing.

Potential socio-economic issues relating to development of the Wellgreen property include opportunities for employment of regional residents, availability of housing, and effects of potential population increases on services and other aspects of community life.

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1.0 PROJECT DESCRIPTION

1.1 Introduction

All-North Resources Ltd. is exploring the bulk tonnage potential of the former Wellgreen nickel-copper-platinum mine located in the Quill Creek drainage, about 35 km northwest of Burwash Landing in southwest Yukon (Figure 1). The property was first staked following discovery by Whitehorse prospectors in 1952. Underground exploration and development by Hudson-Yukon Mining Ltd. (a former subsidiary of Hudson Bay Exploration and Development Ltd.) continued on a sporadic basis until 1972 when relatively small scale underground mining commenced. The mine closed sixteen months later in July, 1973 due to falling nickel prices and unforeseen mining problems. All-North purchased the assets of Hudson-Yukon Mining Ltd in 1987 and retains 100% ownership of the Wellgreen property.

Mineralization has been discovered over a 2 km strike length which includes the old mine workings (Figure 2). The target for the 1987-88 exploration program is low grade disseminated mineralization which would support a relatively large scale open pit and underground mining and milling operation for a period of ten or more years. Commodities expected to be recovered from the operation include nickel, copper, platinum group elements (platinum, palladium, rhodium, osmium, iridium and ruthenium), gold and cobalt. Preliminary metallurgical studies indicate that good base and precious metal recoveries can be achieved by conventional milling and flotation.

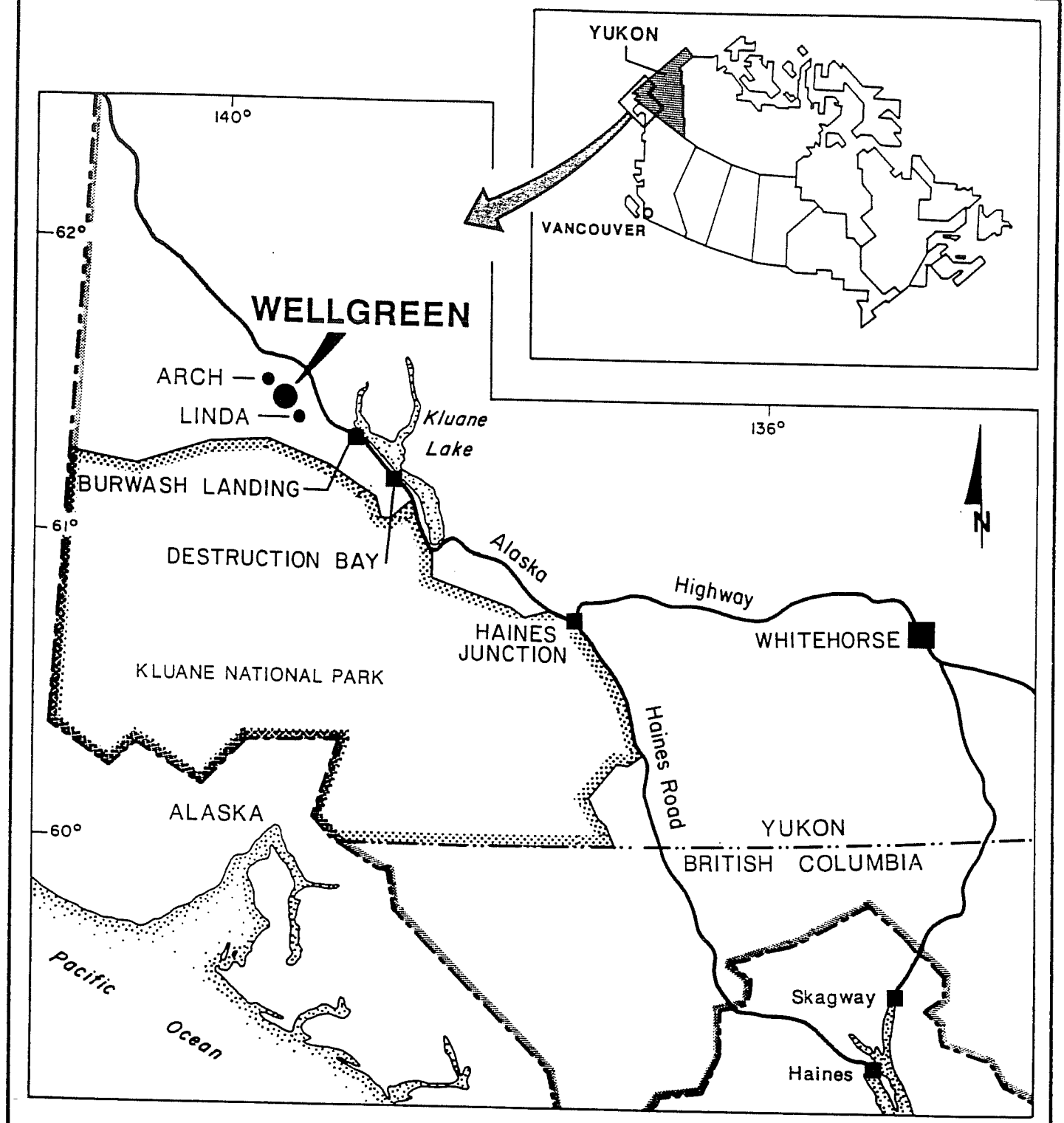


Figure 1

LOCATION
WELLGREEN PROPERTY

YUKON, CANADA

PROPERTY LOCATION MAP

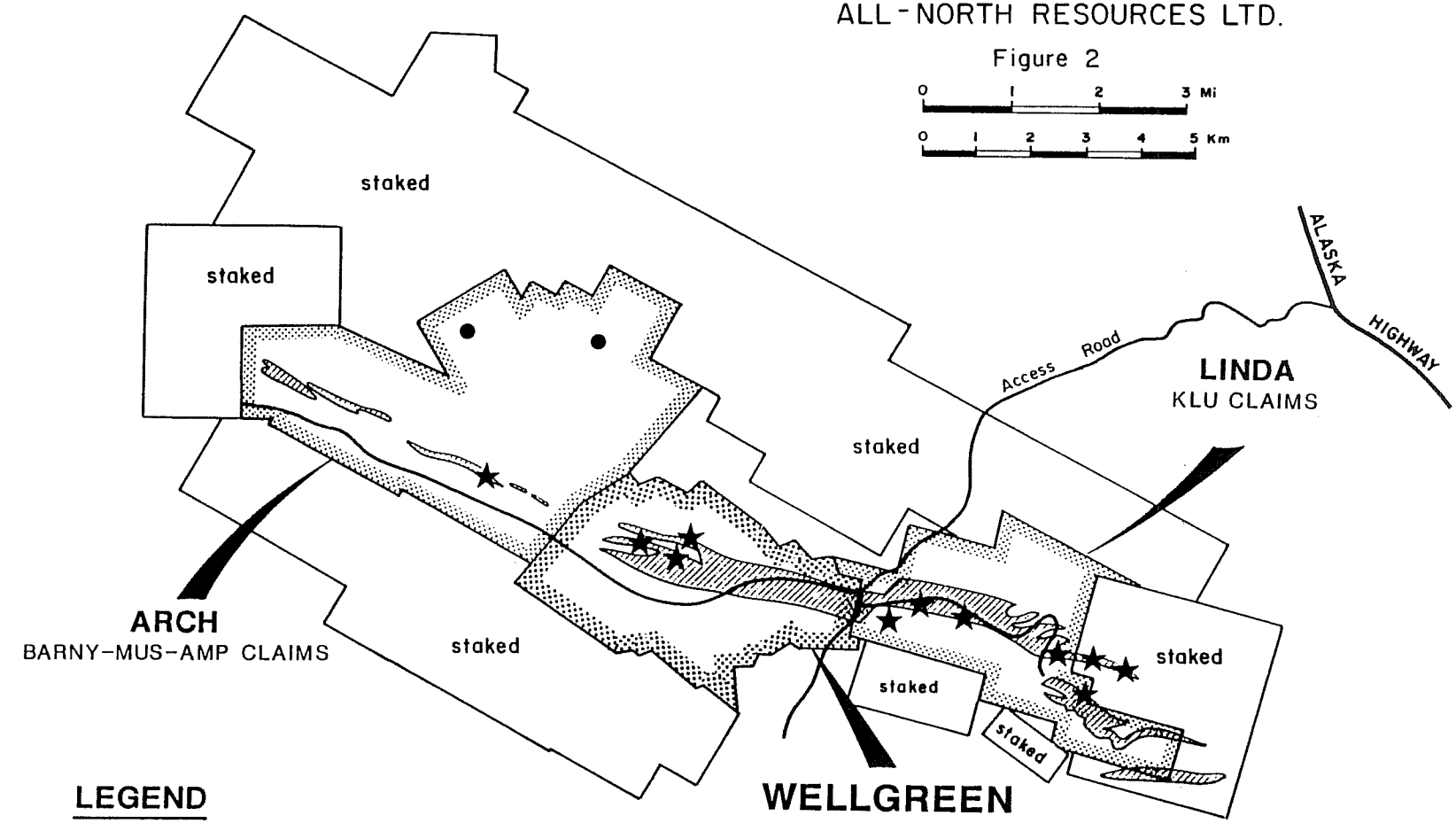
QUILL CREEK AREA

YUKON, CANADA

WELLGREEN DEPOSIT

ALL-NORTH RESOURCES LTD.

Figure 2



1.2 Present Facilities

The mill complex and tailings disposal area for the original Wellgreen Mine were located 14 km north of the minesite at the Alaska Highway. The mill machinery has been removed and the larger buildings have been sold for salvage. Camp facilities were also removed and necessary reclamation and cleanup were carried out.

The present exploration camp is located on the property at the summit between Nickel Creek and Arch Creek. The mine portal has been rehabilitated to enable the resumption of underground diamond drilling from the existing mine workings. A compressor and diesel generator are located at the portal.

1.3 Local Geology

The Wellgreen Project is located along the inboard edge of the Wrangellia tectonic terrane, a volcanic-sedimentary assemblage of Paleozoic to Lower Mesozoic age. Twelve nickel-copper-platinum group element (PGE) occurrences have been discovered along the 200 km long belt since 1952. Mineralization is associated with differentiated mid-Triassic mafic-ultramafic sills that intrude Pennsylvanian to Permian volcanic and sedimentary rocks. The Wellgreen deposit is the most well known of these.

1.4 Mineralization

Mineralization consists of high grade iron-nickel-copper massive sulphide lenses concentrated along basal contacts of the sills, disseminated sulphides in overlying marginal facies gabbro and in associated pyroxenite, as well as irregular replacements, veins and mineralized skarns in altered wallrocks.

An unusual characteristic of the Wellgreen mineralization with respect to other areas of nickel-copper-PGE mineralization is the relatively high ratio of PGE to base metals, Pt:Pd ratios generally exceeding 1:1 and unusually high abundances of rare PGE (rhodium, osmium, ruthenium and iridium) relative to platinum.

1.5 Conceptual Development Plan

The Wellgreen Project is at the advanced exploration stage. Inferred reserves are 20.4 million tons grading 0.67% Cu, 0.36% Ni, 0.026 oz/ton Pt and 0.014 oz/ton Pd. With present metal prices and operating and capital costs, this is insufficient tonnage to undertake an economic feasibility study. The objective of the current phase of exploration is to increase the tonnage by at least 50% by investigating untested areas of potential on the property. If this is successful, a preliminary feasibility study will follow in the fall of 1988 with an aggressive drilling program in 1989 to further define the known areas of mineralization before a production decision is made.

1.6 Reclamation and Abandonment

A detailed reclamation and abandonment plan for the mine, mill and associated facilities will be developed once a decision has been made for the project to proceed. However, preliminary plans would be to remove and revegetate sites after covering with stockpiled surficial materials. The tailing pond would either be sealed or left with standing water and a permanent spillway. All tailing pond dykes would also be reseeded with appropriate mixtures. In open pits, no acid producing surfaces would be left exposed at abandonment. At mine closure, clean water diversion ditches around pits will be stabilized to ensure long term functioning after shut down. Underground workings will be sealed off and secured.

2.0 ENVIRONMENTAL ASPECTS

2.1 Environmental Setting

2.1.1 Location and physiography

The Wellgreen property is located in the Kluane Ranges on the northeastern flank of the St. Elias Mountains, and is adjacent to the Shakwak Trench, a central forested lowland region. The Burwash Uplands lie in the Kluane Ranges 20 km southeast of the study area. The immediate project area is mountainous with elevations ranging from 1370 m to 2200 m. The property lies in the Kluane Game Sanctuary and about 18 km north of Kluane National Park. The claims area occurs in the upper reaches of Quill Creek, which flows northeast into the Kluane River, and Arch Creek, which flows west into the Donjek River. An exploration camp is located in the upper reaches of Arch Creek and the exploration area occurs on the north side of the valley at the divide between Arch and Nickel creeks. Preliminary plans are to use two small lakes in upper Arch Creek, located 1-2 km northwest of the camp, for tailings disposal. The mill site is also expected to be in the upper Arch Creek watershed.

The property access road branches from Kilometre 1788 of the Alaska Highway, about 25 km northwest of Burwash Landing.

2.1.2 Climate

The Wellgreen area lies in the rain shadow of the St. Elias Mountains and has a dry, cold continental climate. The nearest climate station is located at Burwash 30 km southeast of the Wellgreen area at an elevation of 799 m (Environment Canada 1982). The annual precipitation at this station is 30.1 cm, of which 18.2 cm occurs as rainfall primarily during the months of June, July and August. Mean annual snowfall is 115 cm. Precipitation data for the St. Elias Mountains reported by Oosenbrug and Theberge (1980) are similar to that collected at Burwash with mean annual precipitation of 29.0 cm and mean annual snowfall of 128 cm.

Mean monthly temperatures at Burwash range from a high in July of 12.3°C and a low in January of -24.4°C. The elevation at Burwash is about 600 m lower than Wellgreen, so mean annual temperatures are expected to be slightly higher than at Burwash.

Temperature and precipitation data have been collected at the Wellgreen camp since October 1987.

2.1.3 Vegetation

Vegetative cover on the lower elevations (below 1000 m) of the Wellgreen project area consists of boreal forest species, such as white spruce (Picea glauca) and poplar (Populus balsamifera). Riparian vegetation such as willow (Salix sp.), aspen (Populus tremuloides) and

birch (Betula glandulosa) occurs along major streams in the area. The lower slopes and slide areas have stands of aspen, willow, birch and occasional smaller white spruce. An arctic-alpine zone occurs above 1500 m which has only occasional, prostrate trees and a varying cover of birch, willow and forbs. Dominant forbs and shrubs of the higher elevations include Dryas, sedges (Carex sp.), willow (Salix sp.) and birch (Oosenbrug and Theberge 1980).

2.1.4 Wildlife

The Wellgreen project area lies within the Kluane Game Sanctuary, which adjoins Kluane National Park. Big game species occurring in the project area include: caribou (Rangifer tarandus caribou), Dall's sheep (Ovis stonei dalli), moose (Alces alces gigas), grizzly bear (Ursus arctos) and black bear (U. americanus). Caribou and Dall's sheep have the greatest potential for project related impacts.

2.1.5 Fish

The Kluane River system is known to contain chum salmon (Oncorhynchus keta), chinook salmon (O. tshawytscha), Arctic grayling (Thymallus arcticus), round whitefish (Prosopium cylindraceum), lake whitefish (Coregonus clupeaformis), northern pike (Esox lucius), longnose sucker (Catostomus catostomus), burbot (Lota lota) and slimy sculpin (Cottus cognatus). The Donjek River probably contains the same species, but information on this system is limited. Quill and Arch creeks have low fisheries potential and are probably utilized only in

water quality, hydrology and acid generation. Studies in late October 1987 documented specific chum salmon spawning areas in the Kluane River and hydrology and water quality data were collected. During mid March 1988 winter wildlife surveys were conducted and water quality and hydrology data were collected.

The objectives of the environmental studies for the Wellgreen project were to:

- evaluate all existing information for the area and establish its relevance to the project area;
- initiate a program to describe the water quality characteristics of surface and ground waters draining the project area and downstream receiving waters;
- provide preliminary streamflow data by setting up staff gauges on Arch and Quill creeks to provide staff/discharge relationships;
- document groundwater movement through the project area;
- conduct preliminary acid-base accounting tests to determine acid generation potential of host and ore rock;
- document fish resources and fish habitat potential in Arch and Quill creeks and adjacent areas of the Kluane and Donjek rivers; and

- provide an overview of the wildlife resources in the project area.

The following sections present environmental data collected by Norecol in the immediate project area supplemented by existing information where appropriate.

2.2.1 Hydrogeology

This section describes the physical hydrogeology of the Wellgreen area. The chemical hydrogeology is discussed in Section 2.2.3, Water Quality.

At the Wellgreen site, there are two major hydrogeologic domains: the mountainous area (St. Elias Mountains) to the south and west and "flats" consisting of alluvial-fan, fluvial, and glacial deposits to the north and east.

Mountainous Area

The rock in the mountainous area is primarily Pennsylvanian to Triassic igneous and volcanic rock. Because of its relatively old age, the rock is well indurated, resulting in a relatively low hydraulic conductivity, although fracture zones in the rock provide localized conduits for groundwater. The relatively low hydraulic conductivity of the rock combined with discontinuous permafrost in the area generally indicate the rock is relatively impermeable to groundwater (an "aquitard").

There is a layer of talus and overburden lying over the rock which is thin on the slopes and thicker in the

valleys. Although this material has a wide range in grain size (generally cobbles to silt), it is believed to be more permeable than the rock, making it an "aquifer" in the mountainous area when it is not frozen. This overburden aquifer is probably recharged predominately using precipitation. Attempts to auger into the overburden using hand augers to install piezometers during late August 1987 was unsuccessful because of the presence of cobbles and unconsolidated sediment, indicating the need for a power auger or drill rig with casing.

Springs discharging at various road cuts in the exploration area indicate the water table in overburden on the slopes is variable but usually within a few metres of the surface (generally consistent with a few non-stabilized borehole measurements) and is generally parallel to the land surface. This indicates that groundwater moves through the aquifer on the slopes and joins groundwater in the valley overburden. The groundwater in the valleys then likely flows parallel to the creeks.

Along Arch Creek to the west of the camp, there are two lakes being considered for tailings disposal which do not have surface outflows. This indicates the groundwater flow system is the major control on the water balance around the lakes and the proposed tailings area. One measurement of water-table depth in a pit between the two lakes was 0.80 m during August 1987.

Flats

The subsurface deposits to the east and north of the mountains consists of alluvial-fan, fluvial, and glacial materials whose surface elevation decreases toward the Kluane River to the northeast. These deposits are commonly unsorted with grain sizes ranging from cobbles to silt. Near the creeks and river, the finer grain sizes have been washed out. The deposits also locally contain peat and discontinuous permafrost. The permafrost probably limits seasonal groundwater flow to the upper few metres in many areas.

The water table in the flats probably reflects the land surface, decreasing in elevation towards the northeast. If the elevation of Quill Creek is representative of the elevation of the water table, then the water table is a few tens of metres deep where the flats meet the mountains and is generally less than one metre deep in the vicinity of the Kluane River. This provides a hydraulic gradient of roughly 0.01 toward the river where groundwater inflow is known to supply a significant baseflow.

The Kluane River is braided in places. Within the boundaries of the outermost braids, shallow groundwater under the "islands" and river beds can be expected to flow generally parallel to the river.

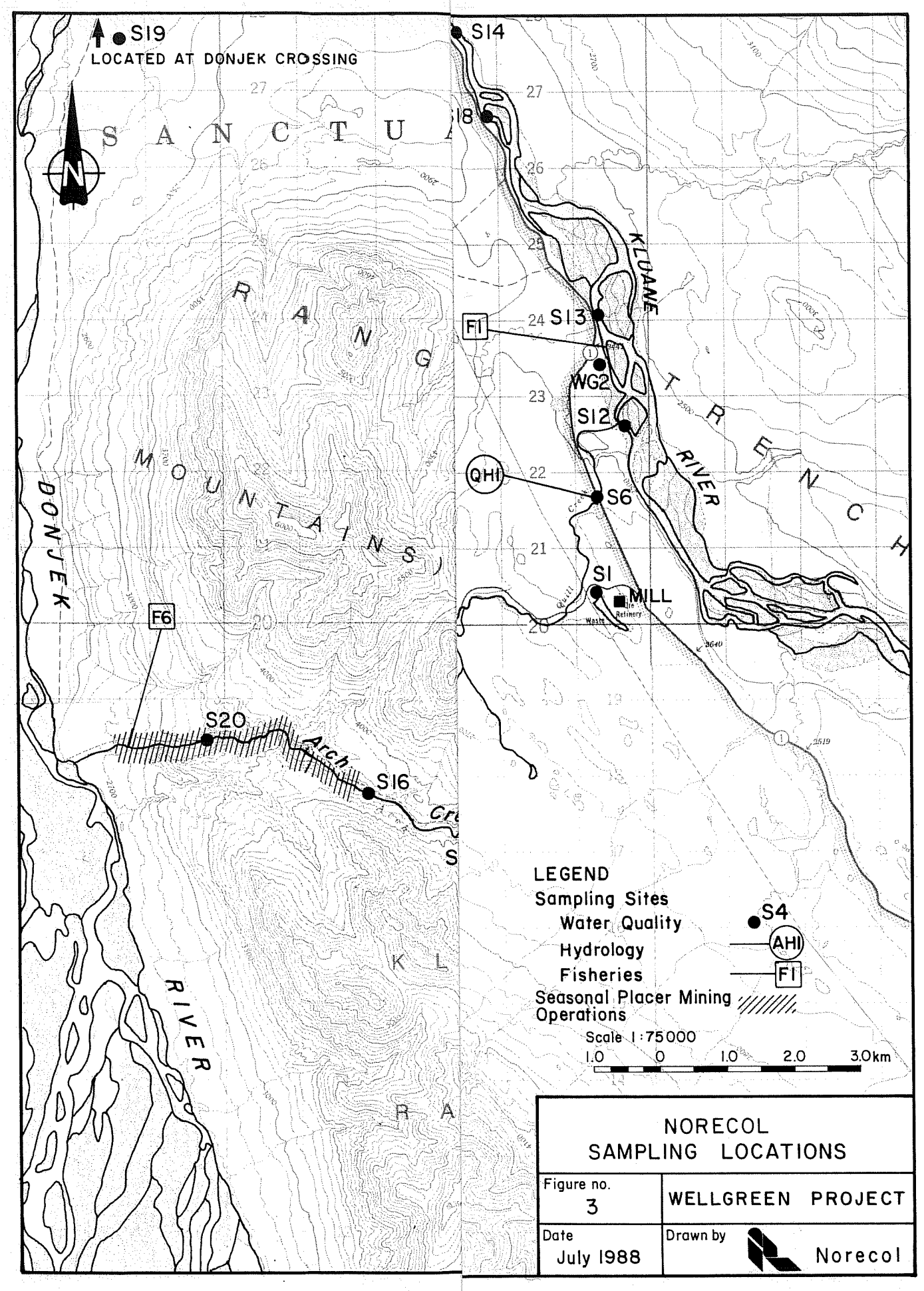
The tailings area from the previous mill operation is located on the flats near the Kluane River. Although there is intermittent surface outflow from the tailings

area into Quill Creek, the behaviour of groundwater in the vicinity is likely more complex. The tailings area probably alternates between a groundwater recharge and discharge zone depending on the seasonal variations in water table elevation. There is a surficial tight clay layer about 1.5 m thick in the vicinity of the tailings, but its extent and its effect on groundwater seepage are unknown. In any case, the tailings area probably has only a negligible influence on the volume of groundwater flow relative to the entire flow in the flats because of its small size. Its impact on groundwater quality is not known.

2.2.2 Surface Water Hydrology

A staff and crest gauge were installed on Arch Creek (Site AH1) and Nickel Creek (Site NH1) on August 25, 1987 (Figure 3). Norecol has measured stream flow at these sites on August 25 and October 27, 1987. The gauges were read frequently by on-site staff until the drilling program was suspended in October 1987. Stream flow measurements and staff gauge readings to-date appear in Table 1.

Lower Arch Creek probably flows all year. The staff gauge on Arch Creek is located in the upper watershed 2.3 km downstream of the lowermost lake being considered for tailings disposal. Most of the flow at this location originates from a high gradient stream on the north side of the valley and an ephemeral stream on the south side of the valley. The upper reaches of



NORECOL
SAMPLING LOCATIONS

Figure no. 3	WELLGREEN PROJECT
Date July 1988	Drawn by Norecol

TABLE 1

HYDROLOGY DATA FOR THE WELLGREEN PROJECT AREA

DATE	NICKEL CREEK		ARCH CREEK	
	STAFF READING (m)	DISCHARGE (m^3/s)	STAFF READING (m)	DISCHARGE (m^3/s)
1987				
AUG. 25	0.250	0.745	0.270	0.408
28	0.215		0.255	
30	0.200		0.245	
SEP. 1	0.180		0.245	
5	0.185		0.225	
7	0.170		0.225	
9	0.160		0.225	
14	0.140		0.220	
16	0.140		0.215	
19	0.135		0.210	
21	0.135		0.205	
23	0.125		0.200	
26	0.125		0.195	
28	0.120		0.190	
OCT. 1	0.120		0.185	
3	0.110		0.180	
5	0.100		0.180	
8	-		0.175	
27	0.320*	0.038	0.145	0.060
1988				
MAR 15	no flow		no flow	

* Reading too high due to ice blockage just downstream.

Arch Creek were dry during field studies in March 1988. No surface outflow occurs from either of the lakes being considered for tailings disposal.

The lower reaches of Quill Creek dry up during periods of low flow. The main area which dries up occurs from just upstream of the mill site at the Alaska Highway down to the mouth. The upper reaches of Quill Creek, including Nickel and Aird creeks, were not flowing during March 1988, and parts of Quill and Nickel Creeks were covered with glaciated ice up to 1 m thick.

2.2.3 Water Quality

Surface water samples were collected in the Wellgreen project area on July 2, August 26 and October 27, 1987 and March 16, 1988. Groundwater samples were collected from pits and natural springs on August 25, 1987 and from the existing adit on August 26 and October 27, 1987 and March 15, 1988. The water quality sampling during the late winter (March, 1988) was restricted by ice conditions and lack of surface water flow in many tributaries. Water quality sites are shown on Figure 3. Seasonal placer operations on Arch and Quill creeks are also shown on this figure since they could effect water qulaity in these streams. Water quality sites are described as follows:

SURFACE WATER SITES:

S1 - tailings pond near old mill site

S4 - Quill Creek, 200 m upstream of Linda Creek

S5 - Quill Creek, 100 m upstream of Nickel Creek

S6 - Quill Creek, at the Alaska Highway

S7 - Nickel Creek, 200 m upstream of Aird Creek

S8 - Aird Creek, near the mouth

S9 - Arch Creek, just upstream of camp

S11 - Linda Creek, 200 m from mouth

S12 - Kluane River, just upstream of Quill Creek

S13 - Kluane River, 1.7 km downstream of Quill Creek

S14 - Kluane River, 6.4 km downstream of Quill Creek

S15 - Arch Creek, 2.3 km downstream of lower lake

S16 - Arch Creek, 4-1 km downstream of lower lake

S17 - Quill Creek, 2.5 km downstream of Linda Creek

S18 - Kluane River, groundwater fed backwater 5.1 km downstream of Quill Creek

GROUNDWATER SITES:

A1 - adit outflow

WG2 - Kluane River flats north of Quill Creek (pit)

WG3,WG4 - exploration area north of camp (natural springs)

WG5 - east end of lower lake on Arch Creek (pit)

Analytical results of the water sampling program and water temperatures appear in Appendix II. These results include ICAP and mass spectrometer scans of samples collected in Aird Creek (S8) and upper Arch Creek (S9) during July 1987.

The surface water of the study area is somewhat alkaline (pH 7.7 - 8.5) and generally has high buffering capacity (total alkalinity varies from 52 - 291 mg $CaCO_3$/L). The water at most sites is moderately to very hard (>100->200 mg $CaCO_3$/L),

although softer water (60-86 mg $CaCO_3$/L) was found at sites S7, S8 and S9 in July. The major cations in these waters are calcium and magnesium, and the major anion is sulfate.

Some seasonal trends in water quality were apparent. Concentrations of suspended solids were high in the summer during the period of high river discharge and were markedly lower in the fall and winter. Elevated concentrations of total metals and total phosphorus were associated with the high suspended solids loads. The pH, hardness and nitrate increased as flows decreased throughout the open water season. Phosphorus tended to decrease seasonally, with lowest concentrations observed in October.

Some spatial patterns were also apparent. Suspended solids levels were low (<5 mg/L) in most of the upper basins, including Quill Creek (S4, S5 and S17), Aird Creek (S8) and Arch Creek (S15 and S16). Particularly high suspended solids levels (>300 mg/L) occurred in Linda Creek (S11) and the Kluane River (S12, S13, S14) during freshet. Consistently higher levels of copper, nickel and selenium were found at the upper basin sites (S8 and S9) than at the other sampling locations. In the winter, the water quality samples from Quill Creek above and below Nickel Creek were similar to each other and to the Arch Creek sample, with the exception of lower concentrations of nitrate in upper Quill Creek (0.238 mg/L at S5), and somewhat softer water in Arch Creek (lower alkalinity, 101 mg/L, and hardness, 191 mg/L). In comparison, the Kluane River in winter

had much higher levels of suspended solids (50 - 70 mg/L) and phosphorus (0.105 mg/L) than the tributaries and lower concentrations of nitrate (0.025 - 0.053 mg/L). Concentration of almost all metals in the Kluane River were equal to or greater than the tributaries, with aluminum (0.9 mg/L) and iron (about 2 mg/L) being particularly high.

Concentrations of aluminum, copper and iron (as total metals) varied directly with the suspended solids load. During the summer months, when levels of suspended solids were high, these metals usually exceeded the guidelines for protection of freshwater aquatic life established by the Canadian Council of Resource and Environment Ministers (CCREM 1987) (Table 2). High concentrations of aluminum are probably associated with the presence of aluminosilicate rock, which is also capable of releasing other metals such as iron. Aluminum, copper and iron were within the CCREM guideline levels in October and March at most sites except in the Kluane River (where the suspended solids levels remained elevated). Total copper concentrations remained above the guidelines at sites S8 (Aird Creek), S9 (Arch Creek) and S11 (Linda Creek) as well.

Other metals were also periodically above the CCREM guidelines. Elevated concentrations of chromium (>0.02 mg/L), nickel, lead and zinc were associated with suspended solids levels above 300 mg/L in the Kluane River (S12, S13, S14). All these metals, except lead, also exceeded the guidelines in Linda Creek (S11) in July when the level of suspended solids was elevated (366 mg/L). Total nickel was higher in upper Arch Creek (S9). Chromium exceeded the more stringent

TABLE 2

WATER QUALITY GUIDELINES FOR THE PROTECTION OF AQUATIC LIFE

PARAMETER	GUIDELINE (mg/L)
Ammonia (total)	2.2 at pH 6.5, temperature 10°C 1.37 at pH 8.0, temperature 1°C
Nitrite	0.06
pH	6.5 - 9.0
Aluminum	0.1 at pH $\geq$ 6.5; $[Ca^{2+}] \geq 4.0$; DOC[1] $\geq$ 2.0 mg/L
Arsenic	0.05
Cadmium	0.00008 at Hardness 60 - 120 mg/L ($CaCO_3$) 0.0013 at Hardness 120 - 180 mg/L ($CaCO_3$) 0.0018 at Hardness >180 mg/L ($CaCO_3$)
Chromium	0.02 to protect fish 0.002 to protect aquatic life including zooplankton and phytoplankton
Copper	0.002 at Hardness 60 - 120 mg/L ($CaCO_3$) 0.003 at Hardness 120 - 180 mg/L ($CaCO_3$) 0.004 at Hardness >180 mg/L ($CaCO_3$)
Iron	0.3
Lead	0.002 at Hardness 60 - 120 mg/L ($CaCO_3$) 0.004 at Hardness 120 - 180 mg/L ($CaCO_3$) 0.007 at Hardness >180 mg/L ($CaCO_3$)
Mercury	0.0001
Nickel	0.065 at Hardness 60 - 120 mg/L ($CaCO_3$) 0.11 at Hardness 120 - 180 mg/L ($CaCO_3$) 0.15 at Hardness >180 mg/L ($CaCO_3$)
Selenium	0.001
Silver	0.0001
Zinc	0.03

(Canadian Council of Resource and Environment Ministers 1987)

DOC - dissolved organic carbon.

guideline for protection of phytoplankton and zooplankton (0.002 mg/L) at all sites. Total selenium concentrations exceeded the guideline at sites S4, S5, S7, S11 and S15 and did not appear correlated with suspended solids levels. Dissolved metals concentrations represented only a small fraction of the total except in the case of selenium and copper. Dissolved copper levels were highest at sites S8, S9 and S15, ranging from 0.001 to 0.008 mg/L. In general, the concentration of metals in surface water was lowest in fall and winter, with the lowest values measured in the October 27 samples.

Groundwater samples were collected at natural seepage sites on road cuts and from shallow pits. The water samples contained sediments eroded from the cuts or disturbed during pit excavation. High concentrations of total aluminum, total iron and sometimes other metals were observed in association with the presence of suspended solids. Total metal levels cannot be considered typical of the groundwater as they probably reflect sediment contamination.

The groundwater at most sites was alkaline (pH 7.5-7.9, total alkalinity 106-206 mg $CaCO_3$/L) and moderately hard (104 - 151 mg $CaCO_3$/L). Concentrations of most dissolved metals were similar to levels measured in the surface waters, but higher levels of dissolved chromium (0.023 mg/L) and dissolved nickel (0.027 mg/L) were found at site WG3 in the exploration area.

The groundwater from the flats in the Kluane River valley (WG2) differed from that of the other sites. It

was very hard (542 mg $CaCO_3$/L) and had high alkalinity (419 mg $CaCO_3$/L), high sulfate (241 mg/L), high total zinc (0.09 mg/L), and a measurable amount of total silver (0.0003 mg/L).

A water sample taken from a groundwater fed back channel of the Kluane River (S18) in winter was significantly different than the mainstem samples (S12, S13). Turbidity and suspended solids were very low in this sample, whereas nitrate and hardness were greater than samples taken in the mainstem. Concentrations of most metals were lower, particularly aluminum and iron which were very high in Kluane mainstem samples. This back channel is a known chum salmon spawning area.

The concentration of total arsenic (0.035 mg/L) was higher in the groundwater sample from the exploration area (WG4) than in the other samples.

The adit water (A1) was very hard (229-838 mg $CaCO_3$/L) with high conductance (770-1410 umhos/cm) and high sulfate concentrations (272-700 mg/L). Concentrations of nickel and selenium consistently exceeded the CCREM guidelines. These metals were present almost entirely in the dissolved form. Total and dissolved arsenic levels were elevated (0.021-0.096 mg/L total, 0.020-0.026 dissolved), but did not exceed the CCREM guideline. In the winter, during dewatering of the adit, there was no measurable effect of this water in the sample taken in lower Quill Creek (S17).

Some water quality monitoring data were collected during the operation of the previous mine in the early

1970's. These data would serve as supplemental background information, but have not been included in this report since few characteristics were analyzed and detection limits were higher than currently is required for water quality interpretations. More recently, Indian and Northern Affairs Canada (INAC) collected water quality samples in the Wellgreen area. INAC sampling occurred in July 1987 and results will be forwarded to Norecol when analyses are complete.

2.2.4 Acid Generation

Three rock samples have been collected and analysed for acid generation potential to date. The source of the rock tested and analysis results are shown in Table 3.

Total sulfur analysis provides an accurate measure of the maximum potential acid which could be generated if all the sulfur is available in a form to be converted to acid. Because the test results are used to calculate the maximum acid generation potential of the samples it is not necessary to consider the method of sulfur conversion, the rate of release of sulfur, or the forms of sulfur present. These other considerations may be important for specific samples which indicate they have a net potential to generate acid, based on the preliminary acid-base accounts.

Calcium carbonate equivalent analyses are a direct measure of the ability of the pulverized rock samples to neutralize a measured amount of acidic solution. Because the samples are pulverized and then treated with acid and heat to complete the reaction the

TABLE 3

ACID NEUTRALIZATION POTENTIALS OF ROCK FROM THE WELLGREEN PROJECT

MATERIAL	SOURCE	PASTE pH	PERCENT SULFUR	ACID AND BASE TONS $CaCO_3$ EQUIVALENT/1000 TONS		
				MAXIMUM POTENTIAL ACIDITY	NEUTRALIZATION POTENTIAL	NET NEUTRALIZING POTENTIAL (BASE-ACID)
Waste Grade Quartzite	Unmineralized quartzite/ siltstone from 30+00E, 1+00N along drill road	8.8	0.007	0.2	48.66	48.46
Waste Grade Peridotite	Unmineralized peridotite/ dunite from 21+50E, 1+10S along drill road	9.8	0.180	5.6	195.39	189.79
Mineralized East Zone Gabbro	Pyrrhotite and chalcopyrite mineralized gabbro from trench 87-11 (coordinates 34+00E, 1+50S)	7.2	9.60	300.0	27.87	-272.13

neutralization potential (calcium carbonate equivalent) is a maximum value.

Results from the assay analyses provide an accurate account of the net neutralization potential (calcium carbonate equivalent). The net neutralizing potential numbers were calculated by subtracting the maximum potential acidity from the neutralization potential (Base - Acid = Net Neutralization Potential). If the net neutralization potential is negative, then this indicates a tendency to be acid generating.

Initial results indicate that the mineralized rock has a high sulfur content and may be acid producing. The waste rock samples appear to be acid consuming with a low sulfur content and high paste pH.

During 1982 EPS (Davidge 1984) conducted acid generation tests on tailings material from the abandoned Wellgreen mine. Results indicated that tailings are acid generating.

2.2.5 Fisheries

Norecol conducted fish sampling and habitat assessments in study area drainages in late August 1987. In addition, a spawning survey was conducted by helicopter in late October 1987 to document chum salmon spawning areas in the Kluane and Donjek rivers. Fish sampling sites are shown on Figure 3 and fish sampling activities are summarized in Table 4. The only fish captured were in the Kluane River near Quill River Creek at site F1 (Table 5).

TABLE 4

SUMMARY OF NORECOL FISH COLLECTION ACTIVITIES IN THE WELLGREEN PROJECT AREA
AUGUST 25 - 26, 1987

SITE	DRAINAGE	LOCATION	METHOD[1]	DURATION	SPECIES[2]		
					AG	BB	SU
F1	Kluane River	800 m downstream of Quill Creek	FT(2) GT(3) ES	19 h 19 h 499 s	4	2	 1
F2	Quill Creek	2 km downstream of Linda Creek	ES	364 s			
F3	Quill Creek	300 m downstream of Linda Creek	ES	346 s			
F4	Nickel Creek	600 m upstream of Aird Creek	ES	465 s			
F5	Arch Creek	lower lake in upper watershed	GN	24 h			
F6	Arch Creek	1 km from mouth	ES	479 s			

1 FT - fish trap (number installed)
GT - minnow trap (number installed)
ES - electroshocking
GN - 5 cm mesh gill net

2 AG - Arctic grayling
BB - burbot
SU - sucker

TABLE 5

FISH SPECIMENS CAPTURED IN THE WELLGREEN PROJECT AREA IN 1987

SITE	DATE	SPECIES[1]	LENGTH (mm)	WEIGHT (g)
F1	Aug. 26	AG	140	29.6
		AG	139	25.4
		BB	125	11.3
		AG	140	25.7
		AG	211	88.0
		BB	350	188.0

[1] AG - Arctic grayling
BB - Burbot

Quill Creek

Quill Creek has a 2 m falls at the Alaska Highway which prevents fish passage to the upper watershed. Fish sampling indicates that Quill Creek does not contain fish upstream of the falls. Low densities of adult and juvenile Arctic grayling have been reported in Quill Creek downstream of the falls during the summer months (Beak 1978; Foothills Pipe Lines 1981). Fish sampling was not possible below the falls in August 1987 due to turbid and high water conditions. This area is expected to receive limited fish usage due to the low habitat capabilities and intermittent flow regime.

Arch Creek

Arch Creek has a 2 km long canyon located 2 km from its mouth. The canyon is probably impassible to fish. The habitat capabilities in the upper watershed above the canyon are very low and no fish are expected to occur in this area. This area is comprised almost entirely of fast flowing riffles and fish holding habitat is almost nonexistent. The habitat capabilities below the canyon are low, although it appears to maintain a flow year round. Fish sampling in this area (F6) yielded no fish, but may be used on a limited basis in the summer months by Arctic grayling from the Donjek River. No habitat suitable for overwintering occurs in this area.

Kluane River

The Kluane River near Quill Creek is recognized as a major chum salmon spawning area. Estimates of escapements of chum salmon to this area have been

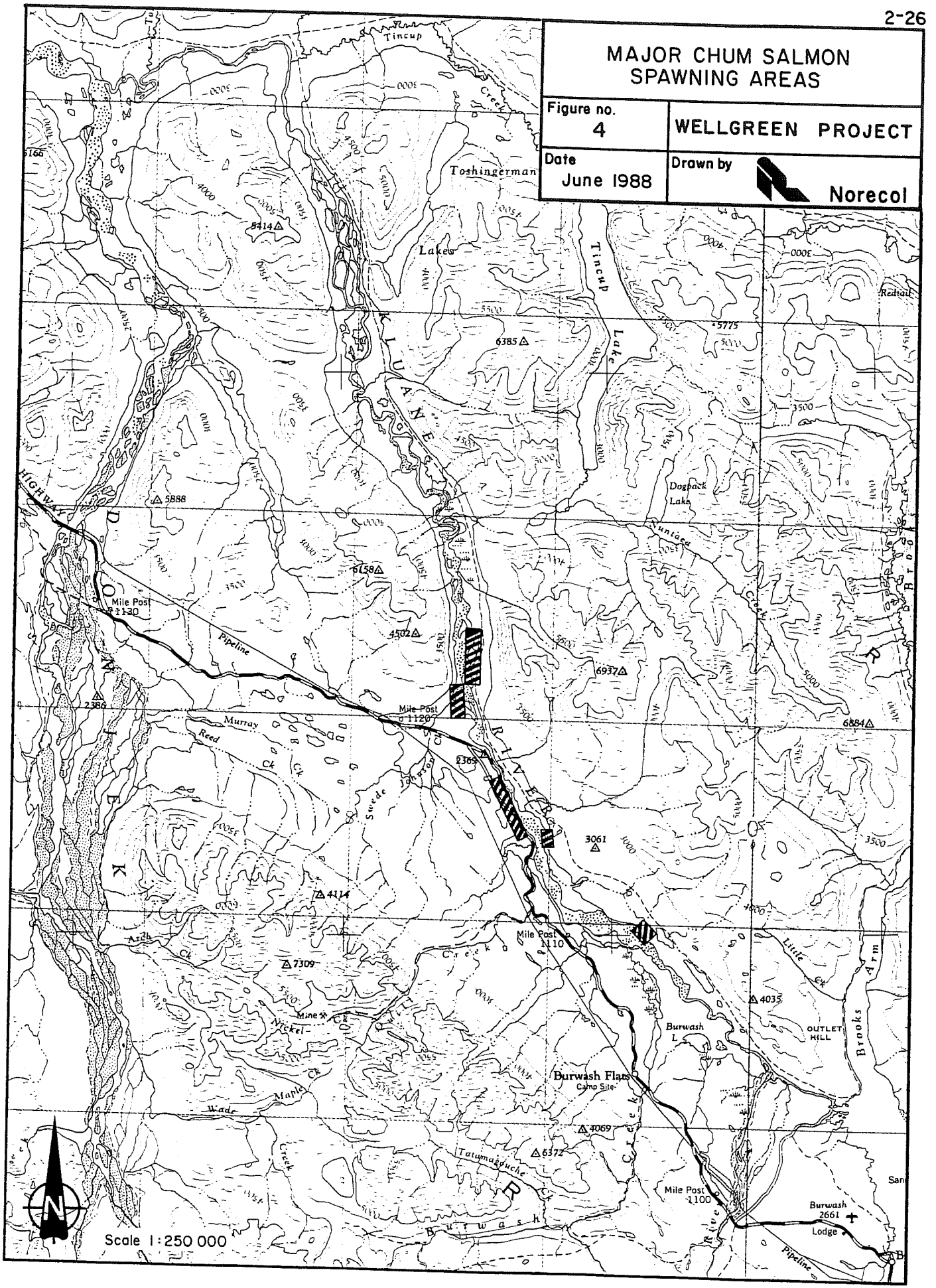
monitored since 1966, but counts are highly variable ranging from 20 to 100,000 (Environmental Management Associates 1980; 1982; Hancock and Marshall 1984; Milligan et al. 1986). Department of Fisheries and Oceans enumerated 11,000 - 13,000 chum spawners in the Kluane River on October 21, 1987 and found about 25% were dead on this date (Hume pers. comm.). Major chum salmon spawning areas identified by Norecol on October 28, 1987 occurred from 10 km upstream of Quill Creek to 15 km downstream of Quill Creek (Figure 4). The spawning survey covered the Kluane River from Kluane Lake to its confluence with the Donjek River, but no other spawning was observed outside of the 25 km area described above. At least 50% of the chum were dead during the Norecol survey indicating that peak spawning probably occurred in mid October.

The preferred habitat for chum salmon spawning in the Kluane River is gravelly backwaters and sloughs fed by upwelling groundwater. The warmer temperatures associated with groundwater discharge prevent solid ice formation in these shallow areas which would otherwise be frozen. In addition, these areas are clearer than the mainstem river (lower levels of suspended solids) and remain free of surface ice cover longer than backwaters not fed by groundwater.

Fish sampling in the Kluane River yielded low densities of Arctic grayling, burbot and suckers, but no juvenile salmon were found. There are some indications that chum salmon fry in the Kluane River overwinter in the backwater areas where they hatch rather than make the

MAJOR CHUM SALMON SPAWNING AREAS

Figure no.	WELLGREEN PROJECT
4	
Date: June 1988	Drawn by: Norecol



long journey downstream at emergence as is usually the case with this species (Hume pers. comm.).

Donjek River

The fisheries resources of the Donjek River are not well known and the system has received limited attention.

The Donjek River was surveyed by Norecol for chum salmon spawning on October 28, 1987. The survey covered the section between the Kluane River and Arch Creek. No salmon were observed in the Donjek River partly due to turbid conditions. A few spawners have been reported in previous years near Reed Creek (Makkonen pers. comm.), but none were evident in this area during this survey. The backwaters in the Donjek River were mostly ice-covered indicating limited influence from groundwater. Anchor ice was observed in the mainstem which would significantly reduce the potential for spawning.

2.2.6 Wildlife

The following sections summarize the information for the major wildlife species occurring in the region and in the Wellgreen project area. This has been based on information available from research studies conducted in the Kluane area, from survey work by the Yukon Territorial government and from surveys conducted for the Alaska Highway Gas Pipeline Project. A reconnaissance survey was conducted in the project area by

Norecol on August 26, 1987 to assess site conditions and a winter survey was flown on March 15, 1988. (Figure 5; Appendix III). Little survey work has been done in the area since the research studies of the early 1980's.

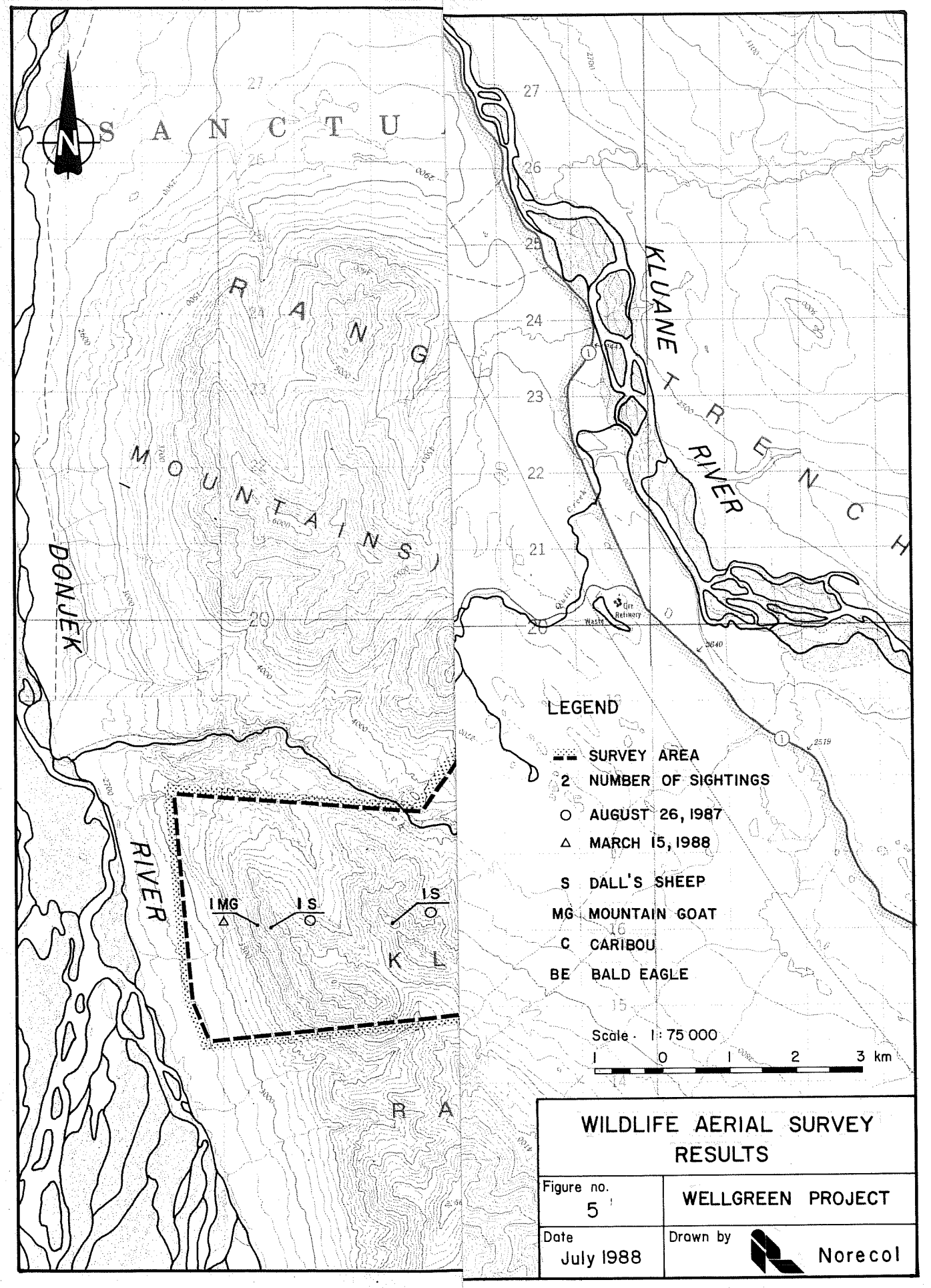
Caribou

Regional Perspective

Caribou in the region belong to the Burwash herd, as described by Gauthier (1984) and Gauthier and Theberge (1985). This herd occupies an area of approximately 1978 km^2, and the population was estimated at a mean of 420 during the early 1980's (Gauthier et al. 1985).

The herd occupies two distinct ranges: the Burwash Uplands lying to the west of the Kluane River and the Brooks Arm Plateaux, lying northeast of the Kluane River. Between these two ranges lies the wide valley of the Kluane River which is encompassed within the Shakwak Trench.

Movements between the Burwash Uplands and Brooks Arm Plateaux ranges generally occur during well defined time periods (early October to mid-November in the fall and mid-April to mid-May in the spring). Movements occur within a well defined corridor, primarily a 14 km zone between Burwash and Glacier creeks (Gauthier et al. 1985). These studies have concluded that changes in caribou numbers on the two distinct ranges are inversely related, with caribou moving from the Burwash Uplands to the Brooks Arm Plateaux range.



WILDLIFE AERIAL SURVEY RESULTS

Figure no. 5	WELLGREEN PROJECT
Date July 1988	Drawn by Norecol

For the Burwash Uplands range, caribou calving, rutting and wintering areas were outlined in the studies by Gauthier (1984). The primary ranges for these activities occur mainly to the south of the Wellgreen project area, although some wintering does appear to occur northward to the Quill Creek area (Gauthier 1984).

A general chronology of annual activity of this herd is described from the information available.

Mid-May to mid-June - calving period in the Burwash Uplands, followed by gradual movement up slope;

Mid-June to late June - post calving aggregations; caribou generally stay at higher elevations (above 1500 m);

July to August - dispersal and movement from post calving aggregations, to higher elevations to escape insects and heat (1500 m to 1800 m);

late August to early September - many caribou are at high elevations (1800 m and above) and form pre-rut aggregations of 20 to 80;

late September to early October - rut period in Burwash Uplands, followed by movements down slope in response to snow accumulations;

early October to mid-November - movements to winter range; either remain in Burwash Uplands or move to Brooks Arm Plateaux by crossing the Shakwak Trench;

mid-November to mid-April - on winter ranges;

mid-April to mid-May - movements back from winter ranges on the Brooks Arm Plateaux to calving areas on the Burwash Uplands.

Habitats and their use on the Burwash Uplands were described by Oosenbrug and Theberge (1980). They found that sedge (Carex sp.) meadow communities were preferred during the summer period and that in general, communities with a significant component of Carex sp. were favoured. These communities also provide caribou winter range. There was an increase in use of the alpine communities with a Carex sp. component from summer to fall, as caribou moved up slope with the receding snow. Dry alpine communities (such as on ridge crests and south exposures) were less favoured, as such site conditions are not conducive to growth of Carex sp. Forest communities appeared to receive little use.

Wellgreen Project Area

There are few references of caribou in the specific Wellgreen project area given by Gauthier (1984), including the calving, rutting and wintering periods. These data were collected during seasonal surveys between 1978 and 1982. Surveys by consultants for the Alaska Highway Gas Pipeline Project have covered parts of the project area. Beak (1979) recorded 5 caribou south of Arch Creek at about 1900 m in March 1979. Yukon Wildlife Branch surveys (quoted in Foothills Pipe Lines (South Yukon) Ltd. 1978) found fresh caribou sign in the Quill Creek area in a February winter survey.

The information reviewed above indicates that the Wellgreen project area lies at the northwestern edge of the Burwash caribou herd's range. Habitat available in the project area is similar to that to the south, though somewhat more steep and rugged. Small groups of caribou were observed by exploration crews during the summer. A band of 4 caribou were observed on August 26, 1987 on a high alpine crest at 1890 m elevation southwest of the Wellgreen camp. This group was on a north aspect, bedded down on a snow bank, a typical situation during the late summer when caribou seek such areas to escape the heat and insects.

The observations by Beak (1979), Foothills Pipe Lines (South Yukon) Ltd. (1978) and Gauthier (1984) indicate that caribou use the Quill Creek - Nickel Creek area during the winter period, though the proximity of this winter use to the project area is not clear. The March 15, 1988 survey by Norecol did not document any caribou or sign in the area surveyed (Figure 5). Calving and rutting may also occur in the vicinity of the project area, though the major areas for calving and rutting lie to the south.

Dall's sheep

Dall's sheep occur throughout the region and inhabit the upper elevations in and around the Wellgreen project area. A March 1979 survey by Beak (1979) recorded 3 sheep in the uplands adjacent to Quill Creek at 1584 m. The Yukon Wildlife Branch (1977) suggested that sheep winter near the abandoned Quill Creek mine and that the population was about 100. However, this has not been confirmed by survey data.

A survey by the Yukon Wildlife Branch on July 26, 1985 documented 69 sheep in the general area around Mt. Wellgreen. These included nursery sheep, lambs and rams (specific age groupings and locations are considered confidential). This appears to be the only survey of the area since Gauthier's (1984) survey work in the late 1970's and early 1980's. Gauthier (pers. comm.) recorded sheep in the Mt. Wellgreen area during his surveys but these have to-date not been documented in any publications. Gauthier (pers. comm.) suggests that sheep in the area are mainly distributed from Mt. Wellgreen west toward the Donjek River, generally staying high on the ridges, even during the winter.

The August 26, 1987 aerial reconnaissance of the Mt. Wellgreen area and vicinity by Norecol (Figure 5) recorded 18 sheep in an area roughly 40 km^2, or 0.45 sheep per km^2. All sheep observed at the time were on the ridge crests or near ridge crests in typical rock and talus escape terrain. Most of those observed were rams; a nursery band of approximately 20 sheep is reported to the northwest (toward the Donjek River), in the range north of Arch Creek (Makkonen pers. comm.).

A late winter survey on March 15, 1988 produced 53 sheep in generally the same area covered during the August 1987 survey (Appendix III). This gives a density of 1.32 sheep per km^2, compared to 0.45 per km^2 during the August 1987 survey.

The late winter observations, plus observations on habitat conditions on the south face of Mt. Wellgreen,

indicate that this slope is used as sheep winter range, at least during the late winter period. There is adequate cover of forbs and grasses, escape terrain nearby, and the steep slope and south aspect result in optimal solar radiation, which reduces snow cover. Wellgreen camp personnel report that sheep were seen on the mid-slopes of Mt. Wellgreen in the spring of 1987. Mr. Doug Makkonen, a helicopter pilot with Trans North Air who has flown in the area for 14 years, reports that sheep generally stay up high on the ridge crests to take advantage of the temperature inversions that occur during the winter. Most sheep observed during the March 1988 survey were on ridge crests, though weather conditions were mild at the time of the survey. Sheep generally appear to stay in the area year round, with no well established movement across valleys or to other ranges (Makkonen pers. comm.).

Dall's sheep in the area would move from their winter ranges to lambing areas and then to the ridge crest during summer. Rutting grounds would be on the upper ridges. Specific areas used for lambing, rutting and wintering have not yet been identified in the area, due to a lack of site specific aerial survey data.

Moose

The project area provides only marginal moose habitat. Only the immediate valley bottom along Nickel Creek and upper Arch Creek and the area around the two ponds west of the camp provide moose summer habitat. Better moose range occurs along the Donjek River and in the Shakwak Trench. Observations of moose in the project area have been infrequent.

Bears

Grizzly bears occur throughout the region and several have been observed by exploration crews in the area. Grizzlies have large home ranges, with interior populations at one bear per 22 to 27 km^2 (Pearson 1975). Several grizzlies could use the project area as part of their home range.

Black bears occur primarily in the forested habitats of the Shakwak Trench and Donjek River valley and there is little suitable black bear habitat in the project area.

Smaller carnivores

A wolf pack hunts in the Burwash Uplands range, as described by Gauthier and Theberge (1986). Primary large prey were caribou and moose and small prey was snowshoe hare (Lepus americanus). Wolves occur throughout the region and may range through the valley bottoms and lower slopes of the project area in search of prey.

A red fox (Vulpes vulpes) den is located on the lower south facing slope of Mt. Wellgreen, in the exploration area. A family with pups was reported there by exploration personnel during the summer of 1987. This den may be used in successive years and lies in proximity to an active exploration area.

Two lynx (Lynx lynx) were observed in the lower Quill Creek area in March 1988. Lynx feed predominantly on snowshoe hares which are relatively abundant in the lower valleys.

Raptors

Golden Eagles are common in the area and two were observed in the Nickel Creek area during the August 26, 1987 aerial reconnaissance. Golden Eagles may nest on bluffs in the general area. Bald Eagles nest in the Shakwak Trench and a concentration of Bald Eagles occurs along the Kluane River in the fall (especially October) at the end of the salmon run. Bald Eagles are not expected on a regular basis in the project area, due to lack of nesting habitat (snags, tall trees) and a food source.

Peregrine Falcons are rare in the southwestern Yukon and no nests were observed during the bird surveys by Beak (1978) for the Alaska Highway Gas Pipeline Project. One Gyrfalcon nest was reported during the Beak (1978) surveys in that projects' very large study area. There is habitat available in the Wellgreen project area for cliff nesting raptors though none have been documented as nesting near the area.

2.3 Potential Environmental Concerns

2.3.1 Wildlife

Since the Wellgreen project lies in the Kluane Game Sanctuary and is close to Kluane National Park the wildlife values in area are considerable. Potential impacts could occur from habitat loss and disturbance to wildlife migration, and ungulate lambing or calving.

Of primary concern from a wildlife point of view are regional and local populations of caribou and Dall's sheep. As mining may involve open pit operations on the lower and mid-elevation slopes of Mt. Wellgreen, as well as developments in the valley bottom, there is a potential for habitat removal and disturbance to local populations.

Caribou appear to use the valley bottom of Quill Creek and Nickel Creek occasionally during some winters. There is little indication of caribou calving or rutting in the specific project area although the range of the Burwash herd's calving and rutting distribution does include the project area.

Of greater sensitivity are Dall's sheep which appear to inhabit the project area on a year-round basis. Distribution during the summer and fall is at high elevations. Lambing and rutting areas may occur in the vicinity of the project area and requires documentation. Both of these phases of their annual cycle are of particular concern. As well, winter range may also be involved on the lower to mid slopes of Mt. Wellgreen, as suggested by the Yukon Wildlife Branch (1977), though the specific altitudinal distribution has not been fully documented for the project area. Effects on sheep range are a particular concern, given the sensitivity of sheep to loss of critical habitats and disturbance on seasonal ranges (e.g., stress factors during lambing, rutting, wintering).

Grizzly bears occur in the region and can occur in the project area during the summer or fall, though not on a

continuous basis. Grizzlies are particularly sensitive to development, not so much for habitat loss or disruption as they have large home ranges, but due to the potential for confrontations with development. Direct conflicts between grizzly bears and developments result in a safety hazard to humans as well as disturbance to bears.

2.3.2 Fisheries

The main fisheries concern for the project is the potential effect on chum salmon spawning in the backwaters of Kluane River. The incubating eggs and rearing juveniles rely on an uncontaminated supply of groundwater. The fact that the tailings pond, and probably the mill, are to be located in the Arch Creek watershed would reduce these concerns significantly. Arch Creek flows into the Donjek River, and both these drainages are not considered to have high fisheries values. Contamination of surface water in Quill Creek would be a concern only as it relates to downstream effects on fisheries resources in the Kluane River. The fisheries values in Quill Creek are low, and low densities of Arctic grayling only occur below the Alaska Highway on a seasonal basis.

2.3.3 Water quality

Because ore rock will be ground and processed in the mill, the resulting tailings represent the main environmental concern for water quality. Water in the proposed tailings may contain elevated levels of metals

and perhaps acidity. This water could enter groundwater or surface drainages, altering the quality of the water. Groundwater controls the water balance in the vicinity of the proposed tailings area and any impact on groundwater will likely be seen in lower Arch Creek. A potential for impact on groundwater quality exists at the old tailings site near the Kluane River.

The major environmental concern associated with water quality is that mining may increase levels of metals in the aquatic environment. Elevated metals levels could occur from the pit, adit, mill site and waste rock dumps. The specific metals of concern appear to be nickel, selenium, arsenic, aluminum, iron, copper, chromium, lead and zinc.

2.3.4 Other environmental concerns

Other environmental concerns related to the Wellgreen project area do not appear to be significant. There appear to be no archaeological sites and there are no Indian land claims affecting the property. Land use conflicts appear minimal.

2.4 Proposed 1988 Environmental Studies

2.4.1 Wildlife

There are adequate data for regional populations of the most significant wildlife in the area (i.e., caribou and Dall's sheep), however, site specific survey data for the immediate project area are lacking. Populations may increase or decrease or shifts in range

use may occur, therefore, the earlier information gathered for the region during the late 1970's to early 1980's (e.g., Gauthier 1984) would not be current enough for a detailed assessment of project related impacts to wildlife populations. The Yukon Wildlife Branch only occasionally flies surveys in the region and the National Parks surveys generally do not cover that part of the Kluane Game Sanctuary. Seasonal surveys are considered necessary to document range use and habitat relationships in the project area. The March 1988 late winter survey has in part filled some of the data gaps.

A spring survey, scheduled for 1988, would provide post lambing distribution and numbers in the project area and immediate vicinity. A program of recording wildlife observations at the Wellgreen camp was instituted in August 1987 and is continuing to provide valuable information for the project.

Additional surveys covering a larger area than the immediate project area are necessary for a full documentation of caribou and sheep populations, to gain a better understanding of seasonal range use, population status and movements. Such information requirements will be addressed during the review phase for the project and implemented prior to detailed project design.

2.4.2 Fisheries

Fisheries studies will be conducted in early August on the Donjek River near Arch Creek and on the groundwater

fed backwaters of the Kluane River downstream of Quill Creek. The fisheries resources in the Donjek River are poorly documented and require further study due to the emphasis on the Arch Creek drainage for tailings disposal and siting of mine facilities. The backwaters of the Kluane River may be utilized by chum salmon fry for summer rearing which requires documentation. These backwaters could be impacted if mining affects the groundwater feeding these areas.

2.4.3 Water quality

Water quality monitoring will continue during 1988 on a modified network of sample sites. A total of nine sites will be included, some of which are new sites. These are:

Site A1 - Adit outflow
Site S4 - Quill Creek, downstream of Nickel Creek
Site S6 - Quill Creek, at Alaska Highway
Site S14- Kluane River, 6 km downstream of Quill Creek
Site S17- Quill Creek, downstream of Linda Creek
Site S19- Donjek River, at the Alaska Highway (new site)
Site S20- Arch Creek, near the mouth (new site)
Site S21- lower lake in upper Arch Creek (new site)
Site S22- upper lake in upper Arch Creek (new site)

Samples will be collected in late May and early August. Water quality sites are shown on Figure 3, which includes the new sites listed above.

2.4.4 Acid generation

Acid-base accounting tests will be conducted on ore and waste rock. Triplicate samples from each lithology that may be mined will be assayed. These samples will be collected throughout the 1988 drilling program.

2.4.5 Waste management

Once metallurgical testing begins samples of tailings will be characterized as to residual reagents and metals levels. This could occur in 1988, but is more likely to be carried out during 1989.

2.4.6 Hydrology

During May, water level gauges will be installed in both of the lakes in upper Arch Creek being considered as potential tailing disposal areas. The information on lake water levels provided by these gauges, along with the precipitation and air temperature data being collected by camp personnel, would be used in determining the rates of evaporation and groundwater seepage to be expected from these ponds should they be used for tailings disposal. Other physical characteristics of the lakes such a depth will also be assessed. Creek discharges at sites AH1 and S16 on Arch Creek, NH1 on Nickel Creek, and sites S5 and S6 on Quill Creek (Figure 3) would also be measured during May.

During June and August discharges would also be measured at the sites outlined above. The information

for the gauged creeks would be used to determine the stage discharge relationships for the creeks while the spot discharge measurements at ungauged locations would be used in determining the variability of the areas hydrologic characteristics.

2.4.7 Hydrogeology

In 1987, installation of piezometers was attempted with hand augers, but the attempts failed because of the coarse and poorly sorted nature of the overburden. Consequently, piezometer installation and associated subsurface stratigraphic exploration requires a drilling rig. It is intended that the hydrogeologic study be performed in conjuction with geotechnical drilling at the site. At this time, it appears that the geotechnical drilling targeted for 1988 will be postponed and, as a result, the hydrogeologic study is also postponed. The only groundwater-related work that can be done is: measure the volume of outflow from the adit, measure adit outflow quality, and identify flowing fractures or drillholes in the adit.

3.0 SOCIO-ECONOMIC CONSIDERATIONS

Socio-economic considerations of the Wellgreen project include the project setting, nearby communities, infrastructure and services, potential socio-economic issues, and proposed future studies.

3.1 Project Setting

The Wellgreen project is located in the southwest corner of the Yukon, between the Alaska Highway and the northern border of Kluane National Park, approximately 315 km northwest of Whitehorse. The nearest communities, Burwash Landing, Destruction Bay and Haines Junction, are approximately 30 km, 50 km and 200 km from the project site, respectively.

The Yukon economy is based mainly on mining and tourism. There are no operating mines in the immediate area of the project, but exploration activity is widespread.

Tourism is an important and growing component of the regional economy. The communities along the Alaska Highway, particularly those close to Kluane National Park, benefit from tourism. The park, which offers wilderness recreation opportunities to visitors, was established in 1972 and covers 22 000 km^2 in the southwest corner of Yukon. Over 50,000 people visited the park in 1987 (Henkel, pers. comm.).

Many of the communities in the area have large Native populations. Trapping and subsistence hunting are very important to the local Native economy.

In larger centres, such as Whitehorse, the federal and territorial governments are major employers.

3.2 Infrastructure and Services

The Alaska Highway, built in the 1940's as part of the war effort, connects Dawson Creek, B.C. with Fairbanks, Alaska, a distance of 1532 miles. The opening of the road established Whitehorse as the Yukon's major transportation centre and ultimately as its capital city in the early 1950's. New roadside settlements, such as Haines Junction, were established and older Native settlements, such as Burwash Landing, grew due to their proximity to the highway. Today, approximately 80% of the Yukon population lives along the Alaska Highway.

Whitehorse

Whitehorse has steadily expanded in size and economic diversification since its establishment as the capital. It is Yukon's largest city, with a population of 19,193 as of September 1987. The population is young, with the largest concentrations of people aged 14 to 44. There are relatively few people over age 55. The population swells dramatically during the summer months with the influx of tourists and seasonally employed people. Overall, Whitehorse is a rapidly growing centre, with a growth rate of 5.4% between September 1986 and September 1987.

Whitehorse is the major administrative, supply and tourist centre in the Yukon. There is a central business district, with many varied stores and businesses. There are also medical clinics, a large modern hospital, numerous schools offering elementary and secondary education, and Yukon College, which offers university level courses. Many students from Yukon's smaller settlements go to Whitehorse for high school. Cultural and recreation facilities include numerous community halls, YWCA, libraries, ice arenas, an indoor year-round pool, ski chalet and curling rink, and baseball diamonds. Yukon College has recreational and cultural facilities, such as theatres. Because of its role as a tourist centre, the city has numerous hotels, motels, and restaurants. There is a major airport with scheduled flights.

Due to the city's relatively rapid growth rate, the Whitehorse housing market is currently experiencing shortages. The vacancy rate for rental accommodation was 0.2% in 1987, and is still very low. The real estate market is very active, with sales of houses, particularly mobile homes and condominiums, much higher in September 1987 than 1986. The number of building permits issued was also greater in 1987.

Haines Junction

Haines Junction is situated at the junction of the Alaska Highway and Haines Road, which traverses Alaska to the ocean port of Haines. The population as of September 1987 was 584, of which approximately 25% is

Native. The population is young, with the largest concentration in the 25-44 age bracket. The Kluane National Park administrative centre is located in Haines Junction and the population increased greatly following the opening of the Park. Other government services such as a Yukon Game Branch office, highway maintenance office, post office, a school, and an RCMP station are also located in Haines Junction. Several gas stations, restaurants, stores, motels and other small businesses are located in the community, fronting the Alaska Highway. There is a small airport but no scheduled flights.

The public school offers grades one to twelve. There is a small medical clinic with two public health nurses in full-time residence and a doctor visits from Whitehorse once a week. Recreation facilities include community halls, a library, skating rink, baseball diamonds, a soccer field, and an indoor heated swimming pool.

Housing and rental accommodation is extremely limited as most, if not all, houses are occupied (Feenstra, pers. comm.).

Burwash Landing

This predominantly Native settlement is the closest community to the Wellgreen project site and is situated on the shore of Kluane Lake. It had a population of 95 in September 1987. Like the other Yukon communities, the population is concentrated in the 25-44 age bracket.

Burwash Landing is an unorganized community. The Indian Band office is the centre of the community and runs various recreational and community-oriented programs. There is a store run by the Band. Other facilities include a tourist lodge, a museum for tourists, a gas station on the highway, a drive-in restaurant, and a guide outfitter. There is an airport but no scheduled flights.

There is no school in Burwash Landing; students must travel to other communities such as Destruction Bay, Haines Junction and Whitehorse. A public health nurse runs a health clinic, and a doctor visits from Whitehorse once a month.

There is no rental accommodation and most if not all, houses are occupied at present (Nimon, pers. comm.).

Destruction Bay

Destruction Bay, a small community on the shore of Kluane Lake, had a September 1987 population of 48. The population declined greatly in recent years due to downscaling of the highway maintenance camp and office. As well, the federal Ministry of Transport transferred maintenance of the Burwash Landing airport from the local office to the Yukon Territorial Government, which established its own office outside of Burwash Landing.

The community has a school offering grades one to eight. There is a motel and small store, a gas station, and a community club. There is also a small health clinic with a resident public health nurse. A doctor visits from Whitehorse once a month. There are several vacant houses in the community due to the recent decline in population. (Sepulveda, pers. comm.).

3.3 Potential Issues

Potential socio-economic issues relate primarily to opportunities for employment of regional residents, availability of housing, and effects of potential population increases on services and other aspects of community life. Potential conflicts with the tourist industry in the area are also a concern.

3.4 Proposed Studies

A detailed socio-economic assessment will be conducted if the project proves feasible. This will include a detailed description of regional communities, labour demand and regional labour supply, and available housing and services. The assessment will consider the effects of projected increases in population, on services and housing, as well as communities attitudes toward and ability to manage growth due to development of the project. Review of government information and interviews with government and community representatives will provide the background for the assessment.

REFERENCES

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Milligan, P.A., W.O. Rublee, D.D. Cornett and R.A.C. Johnston. 1986. The Distribution and Abundance of Chum Salmon (Oncorhynchus keta) in the Upper Yukon River Basin as Determined by a Radio-Tagging and Spaghetti Tagging Program: 1982 - 1983. Fisheries and Oceans. Canadian Technical Report of Fisheries and Aquatic Sciences No. 1351.

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Pearson, A. M. The northern interior grizzly bear Ursus arctos L. Can. Wildl. Serv. Rep. Ser. No. 34., Ottawa.

Sepulveda, P. Personal Communication. Talbot Arm Motel, Destruction Bay. June 30, 1988

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APPENDIX I

ANNOTATED BIBLIOGRAPHY OF ENVIRONMENTAL STUDIES PERTINENT TO THE WELLGREEN PROJECT AREA

(Pages 1 - 6)

Beak Consultants Ltd. 1977. A Spring Inventory of Fishery Resources Along the Proposed Alaska Highway Pipeline in Yukon Territory. Prepared for Foothills Pipe Lines (Yukon) Ltd.

- o brief description of Quill Creek
- o documents falls at Alaska Highway

Beak Consultants Ltd. 1977. Winter Fish Investigation of Selected Watercourses in Yukon Territory. Prepared for Foothills Pipe Lines (Yukon) Ltd.

- o Quill Creek has dry bed and no ice cover in winter at pipeline crossing

Beak Consultants Ltd. 1977. A Survey of Fall Spawning Fish Species in Waterbodies Within the Influence of the Proposed Alaska Highway Pipeline in Yukon Territory. Prepared for Foothills Pipe Lines (Yukon) Ltd.

- o chinook salmon spawners in Kluane River in late August
- o species in Kluane River system include chinook salmon, chum salmon, Arctic grayling, round whitefish, lake whitefish, northern pike, longnose sucker, slimy sculpin

Beak Consultants Ltd. 1978. A Summary of Fishery Investigations in Waterbodies Within the Influence of the Proposed Alaska Highway Pipeline in Yukon Territory, 1976 - 77. Prepared for Foothills Pipe Lines (Yukon) Ltd.

- o important chum spawning near mouth of Quill Creek
- o Quill Creek downstream of Alaska Highway is summer rearing area for Arctic grayling.
- o fish sampling of lower Quill Creek captured adult and juvenile Arctic grayling

Beak Consultants Ltd. 1978. Inventory Studies of Birds Along the Proposed Alaska Highway Gas Pipeline Route, Southern Yukon, Summer 1977.

- o gives abundance of waterfowl, raptors, game birds along sections of the pipeline, but little is relevant to the Quill Creek area

- large numbers of Bald Eagles occur along the Kluane River in late October when they feed on dead salmon

- gives limted information on cliff nesting raptors in the region

Beak Consultants Ltd. 1978. Summer - Fall (1977) Mammal Studies: Proposed Alaska Highway Gas Pipeline Route, Southern Yukon. Prepared for Foothills Pipe Lines (South Yukon) Ltd.

- minimum of 167 caribou use Burwash Uplands as summer range, but estimated at 200 by Parks Canada and Yukon Wildlife Branch

- confirm migration route near Quill Creek

Beak Consultants Ltd. 1979. Winter Ungulate Surveys (1979) Alaska Highway Pipeline Route. Prepared for Foothills Pipe Lines (South Yukon) Ltd.

- aerial surveys counted 3 sheep (@ 1585 m) and 45 caribou (40 @ 1675 m and 5 @ 1070 m) in upland area adjacent to Quill Creek

Davidge, D. 1984. Oxidation of Yukon Mine Tailings. Environmental Protection Service, Yukon Branch. Regional Program Report 84-15.

- surface tailings from the abandoned Wellgreen mine were found to be acid generating

Environment Management Associates. 1980 and 1982. Enumeration of Spawning Salmon in Aquatic Systems Along the Alaska Highway Gas Pipeline in Southern Yukon Territory, 1980 and 1981. Prepared for Foothills Pipe Lines (South Yukon) Ltd.

- major concentrations of chum salmon in Kluane River at mouth of Quill Creek

- most chum spawn in side channels and spring-fed backwaters

Environment Canada. 1985. Historical Streamflow Summary Yukon and Northwest Territories. Water Survey of Canada

- stream flow records for Kluane River at outlet of Kluane Lake (Stn. No. 09CA002) from 1953

Foothills Pipe Lines (South Yukon) Ltd. Burwash Uplands Caribou. 1978.

- compendium of aerial surveys by Parks Canada and Yukon Game Branch
- documented movements through Quill Creek area

Foothills Pipe Lines (Yukon) Ltd. 1976. Public Interest. Volume 5B-1: Environmental Statement

- a review of the baseline environmental setting of the Alaska pipeline including the physical and biological components.
  - terrain and hydrology
  - air and water quality
  - archaeology
  - aesthetics and land use
  - vegetation
  - aquatic systems
  - birds
  - mammals
- lynx, beaver, wolverine are lightly trapped in the area. Marten, fox, mink, muskrat are present.
- description of climate conditions
  - daylight, visibility, precipitation, wind, temperature, snow cover, air quality
- description of Kluane Forest Region
- Water Quality Stations on Quill Creek

  00YTO9CH0002
  00YTO9CH0003
  00YTO9CH0004

- Recreation Potential = moderate

Foothills Pipe Lines (South Yukon) Ltd. 1979. Environmental Impact Statement for the Alaska Highway Gas Pipeline Project.

- o background information on climate, hydrology, water quality, vegetation, fisheries, wildlife, land and resource use, sensitive areas
- o precipitation, temperature, wind, rainfall records at Burwash Airport (km 182) - 24-hr/day observation
- o Quill Creek is at km 59 of the Alaska Pipeline Route and lies within the White drainage system. There is a descriptive Hydrological Database and historical water quality data are available (DINA, WSC for > 5 yrs)
- o densities of Arctic Grayling in Quill Creek $\simeq$ 5 fish/300 m of suitable habitat
- o chum salmon spawning at mouth of Quill Creek at confluence with Kluane River is important
- o Dall Sheep year-round range in upper 1/2 of creek drainage
- o Mountain (Woodland) caribou range in upper 1/2 of drainage
- o no prehistoric sites identified in area
- o Placer claims and mines were identified in the upper watershed of Quill Creek
- o Spring freshet is annual high water event

Foothills Pipe Lines (South Yukon) Ltd. 1981. Environmental Protection Plan Quill Creek Test Program.

- o a review of data for raptors (Foothills Pipe Lines (South Yukon) Ltd. 1978 and 1980), mammals (Yukon Wildlife Branch 1977), and waterfowl (Department of Environment 1979) indicates Golden Eagles and caribou are only identifiable concerns in the Quill Creek area
- o Gauthier (1980) indicate 75% of caribou movement north and south of the Kluane River occurs in a 14 km corridor between Quill and Glacier creeks, with movement peaks in November 1 to January 31 and March 20 to June 10
- o no archaeological sites or burial grounds in Quill Creek area
- o initiated Burwash caribou monitoring study

Foothills Pipe Lines (Yukon) Ltd. 1981. Draft Fisheries Protection Plan

- o identifies critical periods for fish life history phases for southern Yukon
- o lower Quill Creek is rearing and summer habitat for Arctic grayling; chum salmon spawning in Kluane River at mouth

Foothills Pipe Lines (South Yukon) Ltd. 1981. Development of Construction Schedules in Relation to Fisheries and Wildlife Issues.

- o good diagram of caribou and sheep distribution and migration routes in the Quill Creek area
- o documents existing information of chum salmon spawning in Kluane River at the mouth of Quill Creek
- o timing of sensitive fish and wildlife life cycles

Gauthier, D. 1987. Population Limitation in the Burwash Caribou Herd, Southwest Yukon. Ph.D. Thesis, University of Waterloo.

- o Ph.D. thesis and other pertinent papers on 3 year study of caribou and other wildlife in the Burwash Uplands area near Quill Creek
- o regular seasonal surveys were flown over a 3 year period, specifically for caribou
- o caribou use uplands south of Quill Creek during rut and calving
- o occasional use of Quill Creek valley bottom for caribou wintering
- o low densities of moose in area
- o grizzly bear and Dall's sheep in area; sheep use upper ridges in Mt. Wellgreen area, primary ranges are to the west toward the Donjek River

Hancock, M. J. and D. E. Marshall. 1984. Catalogue of Salmon Streams and Spawning Escapements of Sub-Districts 110 and 120 (Yukon-Arctic). Canadian Data Report of Fisheries and Aquatic Sciences. No 474.

- escapements for chum salmon for 1966 to 1982 for the Kluane River
- list American counts for Quill Creek area

Lifeways of Canada Ltd. 1981. Archaeological Inventory. Prepared for Foothills Pipe Lines (South Yukon) Ltd.

- no archaeological sites in Quill Creek area
- area could be used by Dall's sheep and moose

Milligan P. A., W. O. Rublee, D. D. Cornett and R. A. C. Johnston. 1986. The Distribution and Abundance of Chum Salmon (Oncorhynchus keta) in the Upper Yukon River Basin as Determined by a Radio-Tagging and Spaghetti Tagging Program: 1982 - 1983. Canadian Technical Report of Fisheries and Aquatic Sciences No. 1351.

- identified chum spawning in the Kluane River adjacent to Quill Creek
- spawning associated with upwelling groundwater
- greatest concentration about 5 km downstream of Quill Creek
- spawn mid-to late October

Northwest Hydraulic Consultants Ltd. 1980. Stream Inventory. Prepared for Foothills Pipe Lines (South Yukon) Ltd.

- limited description of Quill Creek

Yukon Wildlife Branch. 1977. Alaska Highway Gas Pipeline Project Environmental Concerns and Recommendations

- details wildlife habits and habitats and concerns regarding wildlife in southern Yukon
- the mountain (woodland) caribou Burwash Uplands herd is about 200 and crosses highway between Quill Creek and Halfbreed Creek
- Thinhorn sheep overwinter near the abandoned Quill Creek mine, population given as an "educated guess" at about 100

Yukon Wildlife Branch. 1985. Aerial survey of Kluane area, including Mt. Wellgreen area. July 26, 1985.

- gives general survey locations and classified counts for sheep in area

APPENDIX II

ANALYTICAL RESULTS FOR WATER SAMPLES FROM THE WELLGREEN PROJECT

(Pages 1 - 24)

APPENDIX II

I C A P S C A N

Sample type		fresh water	fresh water	fresh water	fresh water
Identification		Lower Aird Creek S8	Lower Aird Creek S8	Arch Creek @ Camp S9	Arch Creek @ Camp S9
Lab Reference #		7333-001	7333-001	7333-002	7333-002
Analyzed by Plasma Emission Spectroscopy (ICAP)					
Method used		as recd EXTRACTABLE	conc. TOTAL	as recd EXTRACTABLE	conc. TOTAL
Trace Elements					
Silver	Ag	< 0.002	< 0.0002	< 0.002	< 0.0002
Arsenic	As	< 0.2	< 0.02	< 0.2	< 0.02
Boron	B	0.02	0.022	0.01	0.015
Beryllium	Be	< 0.001	< 0.0001	< 0.001	< 0.0001
Bismuth	Bi	< 0.2	< 0.02	< 0.2	< 0.02
Cadmium	Cd	< 0.002	< 0.0002	< 0.002	< 0.0002
Cobalt	Co	< 0.005	0.0010	0.005	0.0081
Chromium	Cr	< 0.002	0.0012	0.006	0.0111
Copper	Cu	0.008	0.0804	0.097	0.181
Mercury	Hg	< 0.05	< 0.005	< 0.05	< 0.005
Molybdenum	Mo	< 0.01	< 0.001	< 0.01	< 0.001
Nickel	Ni	0.010	0.0097	0.081	0.0865
Lead	Pb	< 0.02	0.005	< 0.02	0.005
Antimony	Sb	< 0.05	< 0.005	< 0.05	< 0.005
Selenium	Se	< 0.05	< 0.005	< 0.05	< 0.005
Thorium	Th	< 0.05	< 0.005	< 0.05	< 0.005
Uranium	U	< 0.2	< 0.02	< 0.2	< 0.02
Vanadium	V	< 0.002	< 0.0002	< 0.002	0.0010
Zinc	Zn	< 0.002	0.0052	0.002	0.0057
Major Elements					
Aluminum	Al	0.15	0.201	0.74	1.23
Barium	Ba	0.006	0.0179	0.019	0.0235
Calcium	Ca	20.5	26.2	28.0	28.4
Iron	Fe	0.203	0.344	0.996	2.49
Potassium	K	0.5	0.50	0.5	0.52
Lithium	Li	< 0.05	< 0.005	< 0.05	< 0.005
Magnesium	Mg	3.23	3.93	4.65	4.81
Manganese	Mn	0.008	0.0082	0.060	0.0600
Sodium	Na	1.08	1.095	1.15	1.15
Phosphorus	P	< 0.05	0.012	< 0.05	0.050
Silicon	Si	3.49	3.731	4.08	4.790
Strontium	Sr	0.050	0.0861	0.083	0.0882
Titanium	Ti	< 0.001	0.0035	0.006	0.0287
Zirconium	Zr	< 0.005	< 0.0005	< 0.005	< 0.0005
Results in		mg/l	mg/l	mg/l	mg/l

NOTE: Extractable - includes dissolved metals and metals dissolved by acidifying (preserving) the sample with HNO3.

Total - includes dissolved, extractable and metals dissolved by addition of HNO3 plus heat.

Analyst: _____

APPENDIX II

MASS SPECTROMETER SCAN

AIRD CREEK-SITE S8

Ascending mass order.

ELE	MASS	CONC. (ppb)	ELE	MASS	CONC. (ppb)	ELE	MASS	CONC. (ppb)	ELE	MASS	CONC. (ppb)	ELE	MASS	CONC. (ppb)	ELE	MASS	CONC. (ppb)	ELE	MASS	CONC. (ppb)
			Ti	47	4.648	Ga	71	0.079	Zr	90	0.256	Sn	118	0.000	Nd	146	0.117	Yb	172	0.004	Au	197	0.000
Li	7	0.687	V	51	2.688	Ge	74	0.011	Nb	93	0.035	Sb	121	0.179	Sm	149	0.066	Lu	175	0.004	Hg	200	0.000
Be	9	0.000	Cr	52	4.309	As	75	2.380	Mo	98	0.412	Te	126	0.000	Eu	151	0.014	Hf	178	0.003	Tl	205	0.000
B	11	87.720	Mn	55	29.437	Se	77	0.000	Ru	99	0.000	I	127	0.093	Gd	157	0.002	Ta	181	0.002	Pb	208	0.216
Na	23	493.481	Fe	57	711.047	Br	81	2.768	Rh	103	0.008	Cs	133	0.026	Tb	159	0.001	W	186	0.015	Bi	209	0.000
Mg	24	8,229.061	Co	59	1.323	Se	82	0.000	Pd	104	0.239	Ba	138	4.854	Dy	161	0.031	Re	187	0.002	Th	232	0.000
Al	27	368.699	Ni	60	40.545	Rb	85	0.402	Ag	107	0.012	La	139	0.120	Ho	165	0.009	Os	192	0.000	U	238	0.033
Ca	44	129,457.830	Cu	63	12.187	Sr	88	85.462	Cd	111	0.000	Ce	140	0.127	Er	167	0.000	Ir	193	0.000			
Sc	45	7.264	Zn	68	3.025	Y	89	0.394	In	115	0.000	Pr	141	0.027	Tm	169	0.000	Pt	194	0.006			

Descending Concentration order.

ELE	MASS	CONC. (ppb)	ELE	MASS	CONC. (ppb)	ELE	MASS	CONC. (ppb)	ELE	MASS	CONC. (ppb)	ELE	MASS	CONC. (ppb)	ELE	MASS	CONC. (ppb)	ELE	MASS	CONC. (ppb)	ELE	MASS	CONC. (ppb)
Ca	44	129,457.830	Cu	63	12.187	Co	59	1.323	Ce	140	0.127	Pr	141	0.027	Lu	175	0.004	In	115	0.000	Tm	169	0.000
Mg	24	8,229.061	Sc	45	7.264	Li	7	0.687	La	139	0.120	Cs	133	0.026	Yb	172	0.004	Cd	111	0.000	Bi	209	0.000
Fe	57	711.047	Ba	138	4.854	Mo	98	0.412	Nd	146	0.117	W	186	0.015	Hf	178	0.003	Au	197	0.000	Ir	193	0.000
Na	23	493.481	Ti	47	4.648	Rb	85	0.402	I	127	0.093	Eu	151	0.014	Re	187	0.002	Er	167	0.000	Te	126	0.000
Al	27	368.699	Cr	52	4.309	Y	89	0.394	Ga	71	0.079	Ag	107	0.012	Ta	181	0.002	Hg	200	0.000	Be	9	0.000
B	11	87.720	Zn	68	3.025	Zr	90	0.256	Sm	149	0.066	Ge	74	0.011	Gd	157	0.002	Sn	118	0.000	Th	232	0.000
Sr	88	85.462	Br	81	2.768	Pd	104	0.239	Nb	93	0.035	Ho	165	0.009	Tb	159	0.001	Tl	205	0.000			
Ni	60	40.545	V	51	2.688	Pb	208	0.216	U	238	0.033	Rh	103	0.008	Se	77	0.000	Os	192	0.000			
Mn	55	29.437	As	75	2.380	Sb	121	0.179	Dy	161	0.031	Pt	194	0.006	Se	82	0.000	Ru	99	0.000			

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APPENDIX II

MASS SPECTROMETER SCAN

ARCH CREEK-SITE S9

Ascending mass order.

ELE	MASS	CONC. (ppb)	ELE	MASS	CONC. (ppb)	ELE	MASS	CONC. (ppb)	ELE	MASS	CONC. (ppb)	ELE	MASS	CONC. (ppb)	ELE	MASS	CONC. (ppb)	ELE	MASS	CONC. (ppb)	ELE	MASS	CONC. (ppb)
			Ti	47	43.948	Ga	71	0.000	Zr	90	0.337	Sn	118	0.000	Nd	146	0.710	Yb	172	0.020	Au	197	0.000
Li	7	0.875	V	51	3.562	Ge	74	0.000	Nb	93	0.134	Sb	121	0.160	Sm	149	0.174	Lu	175	0.019	Hg	200	0.000
Be	9	0.000	Cr	52	11.433	As	75	7.609	Mo	98	0.515	Te	126	0.000	Eu	151	0.040	Hf	178	0.027	Tl	205	0.000
B	11	78.480	Mn	55	118.018	Se	77	1.083	Ru	99	0.000	I	127	0.046	Gd	157	0.046	Ta	181	0.001	Pb	208	0.487
Na	23	532.169	Fe	57	1,789.702	Br	81	2.372	Rh	103	0.006	Cs	133	0.072	Tb	159	0.026	W	186	0.026	Bi	209	0.001
Mg	24	9,246.557	Co	59	9.548	Se	82	3.841	Pd	104	0.191	Ba	138	14.960	Dy	161	0.042	Re	187	0.006	Th	232	0.005
Al	27	1,679.546	Ni	60	181.478	Rb	85	0.635	Ag	107	0.037	La	139	0.779	Ho	165	0.029	Os	192	0.000	U	238	0.062
Ca	44	38,829.424	Cu	63	86.069	Sr	88	99.857	Cd	111	0.000	Ce	140	0.994	Er	167	0.064	Ir	193	0.000			
Sc	45	6.618	Zn	68	6.186	Y	89	1.282	In	115	0.000	Pr	141	0.180	Tm	169	0.002	Pt	194	0.011			

Descending Concentration order.

ELE	MASS	CONC. (ppb)	ELE	MASS	CONC. (ppb)	ELE	MASS	CONC. (ppb)	ELE	MASS	CONC. (ppb)	ELE	MASS	CONC. (ppb)	ELE	MASS	CONC. (ppb)	ELE	MASS	CONC. (ppb)	ELE	MASS	CONC. (ppb)
Ca	44	38,829.424	B	11	78.480	V	51	3.562	Mo	98	0.515	Er	167	0.064	Tb	159	0.026	Bi	209	0.001	Cd	111	0.000
Mg	24	9,246.557	Ti	47	43.948	Br	81	2.372	Pb	208	0.487	U	238	0.062	W	186	0.026	Ta	181	0.001	Ge	74	0.000
Fe	57	1,789.702	Ba	138	14.960	Y	89	1.282	Zr	90	0.337	I	127	0.046	Yb	172	0.020	In	115	0.000	Ir	193	0.000
Al	27	1,679.546	Cr	52	11.433	Se	77	1.083	Pd	104	0.191	Gd	157	0.046	Lu	175	0.019	Au	197	0.000	Te	126	0.000
Na	23	532.169	Co	59	9.548	Ce	140	0.994	Pr	141	0.180	Dy	161	0.042	Pt	194	0.011	Hg	200	0.000	Be	9	0.000
Ni	60	181.478	As	75	7.609	Li	7	0.875	Sm	149	0.174	Eu	151	0.040	Re	187	0.006	Sn	118	0.000	Ga	71	0.000
Mn	55	118.018	Sc	45	6.618	La	139	0.779	Sb	121	0.160	Ag	107	0.037	Rh	103	0.006	Tl	205	0.000			
Sr	88	99.857	Zn	68	6.186	Nd	146	0.710	Nb	93	0.134	Ho	165	0.029	Th	232	0.005	Os	192	0.000			
Cu	63	86.069	Se	82	3.841	Rb	85	0.635	Cs	133	0.072	Hf	178	0.027	Tm	169	0.002	Ru	99	0.000			

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APPENDIX II
ANALYTICAL RESULTS FOR WATER SAMPLES FROM THE WELLGREEN PROJECT AREA - SITE: S1

ANALYTICAL PARAMETER	JULY 2/87	AUG. 26/87	OCT. 27/87
pH	7.6	7.7	7.9
Alkalinity (mg $CaCO_3$/L)	69	89	96
Turbidity (NTU)	39	35	37
Conductance (µmhos/cm)	255	265	302
Total Solids (mg/L)	241	217	258
Suspended Solids (mg/L)	3	2	17
EDTA-Hardness (mg $CaCO_3$/L)	142	141	167
Colour (Apha Units)		145	30
Sulfate (mg/L)	79	44	57
Ammonia (mg N/L)	0.010	<0.005	0.042
Nitrate (mg N/L)	<0.005	0.012	0.019
Nitrite (mg N/L)	0.012	<0.002	<0.002
Total Phosphorus (mg P/L)	0.013	0.022	0.017
Total Cyanide (mg/L)	<0.001	<0.001	<0.001
Chloride (mg/L)		2.90	2.74
Calcium (mg/L)		49	56
Magnesium (mg/L)		8.2	10.3
Potassium (mg/L)		1.2	1.1
Sodium (mg/L)		1.7	1.6
TOTAL METALS: (mg/L)			
Ag	<0.0002	<0.0002	<0.0002
Al	0.037	0.030	0.045
As	<0.001	<0.001	<0.001
Ba	0.013	0.013	0.015
Cd	<0.0002	<0.0002	<0.0002
Co	0.011	0.007	0.002
Cr	0.003	<0.001	0.001
Cu	0.0056	0.015	0.0061
Fe	5.4	3.74	7.5
Hg (µg/L)	<0.05	<0.05	<0.05
Mn		0.05	0.04
Mo	<0.005	<0.005	<0.005
Ni	0.61	0.26	0.20
Pb	<0.001	<0.001	<0.001
Sb	<0.002	<0.002	<0.002
Se		<0.001	<0.001
Zn	0.0019	0.0013	0.0016
DISSOLVED METALS: (mg/L)			
Ag	<0.0002	<0.0002	<0.0002
Al	<0.01	0.024	<0.01
As	<0.001	<0.001	<0.001
Ba	0.013	0.013	0.010
Cd	<0.0002	<0.0002	<0.0002
Co	0.003	0.006	0.001
Cr	<0.001	<0.001	<0.001
Cu	0.0022	0.013	0.0025
Fe	0.44	2.47	0.027
Mn		0.05	0.030
Mo	<0.005	<0.005	<0.005
Ni	0.52	0.26	0.13
Pb	<0.001	<0.001	<0.001
Sb	<0.002	<0.002	<0.002
Se		<0.001	<0.001
Zn	<0.0005	0.0009	<0.0005

APPENDIX II
ANALYTICAL RESULTS FOR WATER SAMPLES FROM THE WELLGREEN PROJECT AREA - SITE: S4

ANALYTICAL PARAMETER	JULY 2/87	AUG. 26/87	OCT. 27/87
pH	7.9	8.1	8.5
Alkalinity (mg $CaCO_3$/L)	89	123	171
Turbidity (NTU)	5	0.8	0.2
Conductance (µmhos/cm)	205	310	400
Total Solids (mg/L)	182	208	280
Suspended Solids (mg/L)	13	<1	<1
EDTA-Hardness (mg $CaCO_3$/L)	109	155	218
Colour (Apha Units)		32	<10
Sulfate (mg/L)	30	43	61
Ammonia (mg N/L)	<0.005	0.009	0.010
Nitrate (mg N/L)	0.079	0.126	0.192
Nitrite (mg N/L)	<0.002	<0.002	<0.002
Total Phosphorus (mg P/L)	0.019	0.015	0.007
Total Cyanide (mg/L)	<0.001	<0.001	<0.001
Chloride (mg/L)		0.28	0.32
Calcium (mg/L)		53	74
Magnesium (mg/L)		10.5	14.1
Potassium (mg/L)		0.56	0.76
Sodium (mg/L)		3.9	6.9
TOTAL METALS: (mg/L)			
Ag	<0.0002	<0.0002	<0.0002
Al	0.43	0.11	<0.01
As	0.003	<0.001	<0.001
Ba	0.020	0.031	0.048
Cd	<0.0002	<0.0002	<0.0002
Co	0.002	<0.001	<0.001
Cr	0.004	0.001	<0.001
Cu	0.010	0.0047	0.0015
Fe	0.75	0.20	0.029
Hg (µg/L)	<0.05	<0.05	<0.05
Mn		0.0093	0.0045
Mo	<0.005	<0.005	<0.005
Ni	0.020	0.005	<0.002
Pb	<0.001	<0.001	<0.001
Sb	<0.002	<0.002	<0.002
Se		0.002	0.002
Zn	0.0013	0.0005	<0.0005
DISSOLVED METALS: (mg/L)			
Ag	<0.0002	<0.0002	<0.0002
Al	0.010	0.010	<0.01
As	0.002	<0.001	<0.001
Ba	0.020	0.027	0.044
Cd	<0.0002	<0.0002	<0.0002
Co	<0.002	<0.001	<0.001
Cr	0.002	<0.001	<0.001
Cu	0.0040	0.0038	0.0014
Fe	0.022	0.018	0.009
Mn		0.0012	0.0040
Mo	<0.005	<0.005	<0.005
Ni	0.004	0.005	<0.002
Pb	<0.001	<0.001	<0.001
Sb	<0.002	<0.002	<0.002
Se		0.002	0.002
Zn	<0.0005	<0.0005	<0.0005

APPENDIX II
ANALYTICAL RESULTS FOR WATER SAMPLES FROM THE WELLGREEN PROJECT AREA - SITE: S7

ANALYTICAL PARAMETER	JULY 2/87	AUG. 26/87	OCT. 27/87
pH	7.8	8.0	8.1
Alkalinity (mg $CaCO_3$/L)	86	121	169
Turbidity (NTU)	12	1.2	0.2
Conductance (µmhos/cm)	165	245	350
Total Solids (mg/L)	190	162	225
Suspended Solids (mg/L)	48	2	<1
EDTA-Hardness (mg $CaCO_3$/L)	86	135	192
Colour (Apha Units)		17	<10
Sulfate (mg/L)	11	18	28
Ammonia (mg N/L)	<0.005	<0.005	0.016
Nitrate (mg N/L)	0.122	0.190	0.254
Nitrite (mg N/L)	<0.002	<0.002	<0.002
Total Phosphorus (mg P/L)	0.050	0.025	0.010
Total Cyanide (mg/L)	<0.001	<0.001	<0.001
Chloride (mg/L)		1.40	1.72
Calcium (mg/L)		37	49
Magnesium (mg/L)		12.5	22.5
Potassium (mg/L)		0.53	0.72
Sodium (mg/L)		2.9	4.8
TOTAL METALS: (mg/L)			
Ag	<0.0002	<0.0002	<0.0002
Al	1.25	0.12	0.013
As	0.002	<0.001	<0.001
Ba	0.039	0.039	0.071
Cd	<0.0002	<0.0002	<0.0002
Co	0.006	<0.001	<0.001
Cr	0.015	0.006	0.007
Cu	0.015	0.0043	0.0016
Fe	1.68	0.19	0.027
Hg (µg/L)	<0.05	<0.05	<0.05
Mn		0.0082	0.0015
Mo	<0.005	<0.005	<0.005
Ni	0.031	0.009	0.008
Pb	<0.001	<0.001	<0.001
Sb	<0.002	<0.002	<0.002
Se		0.001	0.001
Zn	0.0050	0.0005	<0.0005
DISSOLVED METALS: (mg/L)			
Ag	<0.0002	<0.0002	<0.0002
Al	0.032	0.012	<0.01
As	0.001	<0.001	<0.001
Ba	0.023	0.039	0.070
Cd	<0.0002	<0.0002	<0.0002
Co	<0.002	<0.001	<0.001
Cr	0.001	0.003	0.006
Cu	0.0047	0.0034	0.0013
Fe	0.04	0.019	0.005
Mn		0.0013	<0.001
Mo	<0.005	<0.005	<0.005
Ni	0.002	0.004	<0.002
Pb	<0.001	<0.001	<0.001
Sb	<0.002	<0.002	<0.002
Se		0.001	0.001
Zn	0.0022	<0.0005	<0.0005

APPENDIX II
ANALYTICAL RESULTS FOR WATER SAMPLES FROM THE WELLGREEN PROJECT AREA - SITE: S8

ANALYTICAL PARAMETER	JULY 2/87	AUG. 26/87	OCT. 27/87
pH	7.7	8.0	8.4
Alkalinity (mg $CaCO_3$/L)	52	66	130
Turbidity (NTU)	3.7	0.5	0.2
Conductance (µmhos/cm)	120	220	560
Total Solids (mg/L)	95	155	457
Suspended Solids (mg/L)	8	<1	<1
EDTA-Hardness (mg $CaCO_3$/L)	60	112	324
Color (Apha Units)		14	<10
Sulfate (mg/L)	15	46	210
Ammonia (mg N/L)	<0.005	0.006	0.020
Nitrate (mg N/L)	0.040	0.023	0.085
Nitrite (mg N/L)	<0.002	<0.002	<0.002
Total Phosphorus (mg P/L)	0.023	0.015	0.011
Total Cyanide (mg/L)	<0.001	<0.001	<0.001
Chloride (mg/L)		0.12	0.78
Calcium (mg/L)		36	84
Magnesium (mg/L)		7.1	35
Potassium (mg/L)		0.41	1.1
Sodium (mg/L)		1.4	4.7
TOTAL METALS: (mg/L)			
Ag	<0.0002	<0.0002	<0.0002
Al	0.19	0.015	<0.01
As	0.004	<0.001	0.002
Ba	0.006	0.008	0.021
Cd	<0.0002	<0.0002	<0.0002
Co	<0.002	<0.001	<0.001
Cr	0.003	<0.001	<0.001
Cu	0.0084	0.0049	0.0029
Fe	0.38	0.07	0.011
Hg (µg/L)	<0.05	<0.05	<0.05
Mn		0.0010	<0.001
Mo	<0.005	<0.005	<0.005
Ni	0.014	0.010	0.040
Pb	<0.001	<0.001	<0.001
Sb	<0.002	<0.002	<0.002
Se		0.002	0.006
Zn	0.0010	<0.0005	<0.0005
DISSOLVED METALS: (mg/L)			
Ag	<0.0002	<0.0002	<0.0002
Al	0.020	0.011	<0.01
As	0.001	<0.001	<0.001
Ba	<0.005	0.008	0.017
Cd	<0.0002	<0.0002	<0.0002
Co	<0.002	<0.001	<0.001
Cr	<0.001	<0.001	<0.001
Cu	0.0042	0.0041	0.0027
Fe	0.038	0.014	0.010
Mn		<0.001	<0.001
Mo	<0.005	<0.005	<0.005
Ni	0.004	0.007	0.014
Pb	<0.001	<0.001	<0.001
Sb	<0.002	<0.002	<0.002
Se		0.002	0.006
Zn	0.0005	<0.0005	<0.0005

APPENDIX II
ANALYTICAL RESULTS FOR WATER SAMPLES FROM THE WELLGREEN PROJECT AREA - SITE: S14

ANALYTICAL PARAMETER	JULY 2/87
pH	7.9
Alkalinity (mg $CaCO_3$/L)	100
Turbidity (NTU)	220
Conductance (µmhos/cm)	210
Total Solids (mg/L)	1039
Suspended Solids (mg/L)	817
EDTA-Hardness (mg $CaCO_3$/L)	111
Color (Apha Units)	
Sulfate (mg/L)	34
Ammonia (mg N/L)	0.015
Nitrate (mg N/L)	0.020
Nitrite (mg N/L)	<0.002
Total Phosphorus (mg P/L)	0.900
Total Cyanide (mg/L)	<0.001
Chloride (mg/L)	
TOTAL METALS: (mg/L)	
Ag	<0.0002
Al	9.5
As	0.010
Ba	0.19
Cd	0.0006
Co	0.032
Cr	0.06
Cu	0.04
Fe	12.1
Hg (µg/L)	<0.05
Mn	
Mo	<0.005
Ni	0.12
Pb	0.006
Sb	<0.002
Se	
Zn	0.05
DISSOLVED METALS: (mg/L)	
Ag	<0.0002
Al	0.014
As	<0.001
Ba	0.020
Cd	<0.0002
Co	<0.002
Cr	<0.001
Cu	0.0010
Fe	0.009
Mn	
Mo	<0.005
Ni	<0.002
Pb	<0.001
Sb	<0.002
Se	
Zn	<0.0005

APPENDIX II
ANALYTICAL RESULTS FOR WATER SAMPLES FROM THE WELLGREEN PROJECT AREA - SITE: S15

ANALYTICAL PARAMETER	AUG. 26/87	OCT. 27/87
pH	8.0	8.1
Alkalinity (mg $CaCO_3$/L)	142	142
Turbidity (NTU)	4.5	0.2
Conductance (µmhos/cm)	340	388
Total Solids (mg/L)	234	229
Suspended Solids (mg/L)	8	<1
EDTA-Hardness (mg $CaCO_3$/L)	118	192
Colour (Apha Units)	<10	<10
Sulfate (mg/L)	31	47
Ammonia (mg N/L)	0.007	0.010
Nitrate (mg N/L)	0.170	0.311
Nitrite (mg N/L)	<0.002	<0.002
Total Phosphorus (mg P/L)	0.031	0.005
Total Cyanide (mg/L)	<0.001	<0.001
Chloride (mg/L)	0.28	0.18
Calcium (mg/L)	65	63
Magnesium (mg/L)	10.3	10.9
Potassium (mg/L)	0.57	0.54
Sodium (mg/L)	3.1	2.9
TOTAL METALS: (µg/L)		
Ag	<0.0002	<0.0002
Al	0.23	<0.01
As	<0.001	<0.001
Ba	0.059	0.076
Cd	<0.0002	<0.0002
Co	<0.001	<0.001
Cr	0.004	0.001
Cu	0.0026	0.0005
Fe	0.45	0.007
Hg (µg/L)	<0.05	<0.05
Mn	0.023	<0.001
Mo	<0.005	<0.005
Ni	0.003	<0.002
Pb	<0.001	<0.001
Sb	<0.002	<0.002
Se	0.002	0.002
Zn	0.0013	<0.0005
DISSOLVED METALS: (µg/L)		
Ag	<0.0002	<0.0002
Al	0.019	<0.01
As	<0.001	<0.001
Ba	0.053	0.075
Cd	<0.0002	<0.0002
Co	<0.001	<0.001
Cr	0.001	0.001
Cu	0.0010	0.0005
Fe	0.041	0.005
Mn	<0.001	<0.001
Mo	<0.005	<0.005
Ni	<0.002	<0.002
Pb	<0.001	<0.001
Sb	<0.002	<0.002
Se	0.002	0.002
Zn	<0.0005	<0.0005

APPENDIX II

ANALYTICAL RESULTS FOR WATER SAMPLES FROM
THE WELLGREEN PROJECT AREA - SITE: S16

ANALYTICAL PARAMETER	MAR. 15/88
pH	8.0
Alkalinity (mg $CaCO_3$/L)	101
Turbidity (NTU)	0.2
Conductance (µmhos/cm)	360
Total Solids (mg/L)	234
Suspended Solids (mg/L)	<1
EDTA-Hardness (mg $CaCO_3$/L)	191
Color (Apha Units)	<5
Sulfate (mg/L)	50
Ammonia (mg N/L)	<0.005
Nitrate (mg N/L)	0.450
Nitrite (mg N/L)	<0.002
Total Phosphorus (mg P/L)	<0.003
Total Cyanide (mg/L)	<0.001
Chloride (mg/L)	0.22
Calcium (mg/L)	60
Magnesium (mg/L)	10.8
Potassium (mg/L)	0.80
Sodium (mg/L)	3.4
TOTAL METALS: (mg/L)	
Ag	<0.0002
Al	<0.01
As	<0.001
Ba	0.14
Cd	<0.0002
Co	<0.001
Cr	0.002
Cu	0.0005
Fe	0.031
Hg (µg/L)	<0.05
Mn	<0.001
Mo	<0.005
Ni	<0.002
Pb	<0.001
Sb	<0.002
Se	<0.001
Zn	0.0005
DISSOLVED METALS: (mg/L)	
Ag	<0.0002
Al	<0.01
As	<0.001
Ba	0.10
Cd	<0.0002
Co	<0.001
Cr	0.001
Cu	0.0005
Fe	0.005
Mn	<0.001
Mo	<0.005
Ni	<0.002
Pb	<0.001
Sb	<0.002
Se	<0.001
Zn	<0.0005

APPENDIX II

ANALYTICAL RESULTS FOR WATER SAMPLES FROM THE WELLGREEN PROJECT AREA - SITE: S17

ANALYTICAL PARAMETER	MAR. 15/88
pH	8.1
Alkalinity (mg $CaCO_3$/L)	166
Turbidity (NTU)	1.9
Conductance (µmhos/cm)	448
Total Solids (mg/L)	304
Suspended Solids (mg/L)	4
EDTA-Hardness (mg $CaCO_3$/L)	233
Color (Apha Units)	<5
Sulfate (mg/L)	79
Ammonia (mg N/L)	<0.005
Nitrate (mg N/L)	0.320
Nitrite (mg N/L)	<0.002
Total Phosphorus (mg P/L)	0.022
Total Cyanide (mg/L)	<0.001
Chloride (mg/L)	0.48
Calcium (mg/L)	69
Magnesium (mg/L)	15.8
Potassium (mg/L)	0.80
Sodium (mg/L)	7.1
TOTAL METALS: (mg/L)	
Ag	<0.0002
Al	0.045
As	<0.001
Ba	0.08
Cd	<0.0002
Co	<0.001
Cr	0.001
Cu	0.0020
Fe	0.12
Hg (µg/L)	<0.05
Mn	0.0033
Mo	<0.005
Ni	0.002
Pb	<0.001
Sb	<0.002
Se	<0.001
Zn	<0.0005
DISSOLVED METALS: (mg/L)	
Ag	<0.0002
Al	<0.01
As	<0.001
Ba	0.061
Cd	<0.0002
Co	<0.001
Cr	<0.001
Cu	0.0015
Fe	0.005
Mn	<0.001
Mo	<0.005
Ni	<0.002
Pb	<0.001
Sb	<0.002
Se	<0.001
Zn	<0.0005

APPENDIX II

ANALYTICAL RESULTS FOR WATER SAMPLES FROM
THE WELLGREEN PROJECT AREA - SITE: S18

ANALYTICAL PARAMETER	MAR. 15/88
pH	7.9
Alkalinity (mg $CaCO_3$/L)	180
Turbidity (NTU)	1.0
Conductance (µmhos/cm)	410
Total Solids (mg/L)	275
Suspended Solids (mg/L)	2
EDTA-Hardness (mg $CaCO_3$/L)	224
Color (Apha Units)	<5
Sulfate (mg/L)	57
Ammonia (mg N/L)	0.008
Nitrate (mg N/L)	0.204
Nitrite (mg N/L)	<0.002
Total Phosphorus (mg P/L)	<0.003
Total Cyanide (mg/L)	<0.001
Chloride (mg/L)	0.66
Calcium (mg/L)	55
Magnesium (mg/L)	17.3
Potassium (mg/L)	1.6
Sodium (mg/L)	4.7
TOTAL METALS: (mg/L)	
Ag	<0.0002
Al	<0.01
As	<0.001
Ba	0.070
Cd	<0.0002
Co	<0.001
Cr	0.002
Cu	0.0005
Fe	0.032
Hg (µg/L)	<0.05
Mn	0.0013
Mo	<0.005
Ni	<0.002
Pb	<0.001
Sb	<0.002
Se	<0.001
Zn	<0.0005
DISSOLVED METALS: (mg/L)	
Ag	<0.0002
Al	<0.01
As	<0.001
Ba	0.053
Cd	<0.0002
Co	<0.001
Cr	0.001
Cu	<0.0005
Fe	0.005
Mn	<0.001
Mo	<0.005
Ni	<0.002
Pb	<0.001
Sb	<0.002
Se	<0.001
Zn	<0.0005

APPENDIX II
ANALYTICAL RESULTS FOR WATER SAMPLES FROM
THE WELLGREEN PROJECT AREA - SITE: A1

ANALYTICAL PARAMETER	AUG. 26/87	OCT. 27/87	MAR. 15/88
pH	8.0	8.3	8.2
Alkalinity (mg $CaCO_3$/L)	203	223	148
Turbidity (NTU)	0.7	1.1	100
Conductance (µmhos/cm)	770	918	1410
Total Solids (mg/L)	632	768	1403
Suspended Solids (mg/L)	<1	<1	203
EDTA-Hardness (mg $CaCO_3$/L)	229	565	838
Colour (Apha Units)	<10	<10	<10
Sulfate (mg/L)	272	313	700
Ammonia (mg N/L)	0.051	0.044	0.213
Nitrate (mg N/L)	0.112	0.124	0.048
Nitrite (mg N/L)	<0.002	<0.002	<0.002
Total Phosphorus (mg P/L)	0.022	0.018	0.147
Total Cyanide (mg/L)	<0.001	<0.001	<0.001
Chloride (mg/L)	0.50	0.60	2.98
Calcium (mg/L)	77	86	82
Magnesium (mg/L)	67	90	140
Potassium (mg/L)	1.3	1.2	1.9
Sodium (mg/L)	11.3	19.1	31
TOTAL METALS: (mg/L)			
Ag	<0.0002	<0.0002	<0.0002
Al	0.011	0.13	3.3
As	0.021	0.038	0.096
Ba	0.009	0.008	0.031
Cd	<0.0002	<0.0002	<0.0002
Co	0.003	0.006	0.08
Cr	0.003	0.036	0.26
Cu	0.0045	0.010	0.38
Fe	0.10	0.37	19.2
Hg (µg/L)	<0.05	<0.05	<0.05
Mn	0.04	0.05	0.43
Mo	0.011	0.012	0.015
Ni	0.30	0.22	1.07
Pb	<0.001	<0.001	<0.001
Sb	<0.002	<0.002	<0.002
Se	0.016	0.014	<0.001
Zn	0.0024	0.0022	0.04
DISSOLVED METALS: (mg/L)			
Ag	<0.0002	<0.0002	<0.0002
Al	0.010	<0.01	<0.01
As	0.020	0.021	0.026
Ba	0.006	0.008	0.013
Cd	<0.0002	<0.0002	<0.0002
Co	0.003	0.003	0.004
Cr	<0.001	0.001	<0.001
Cu	0.0022	0.0006	<0.0005
Fe	0.05	0.018	0.021
Mn	0.04	0.04	0.15
Mo	0.009	0.012	0.015
Ni	0.30	0.16	0.42
Pb	<0.001	<0.001	<0.001
Sb	<0.002	<0.002	<0.002
Se	0.016	0.014	<0.001
Zn	0.0020	0.0015	<0.0005

APPENDIX II
ANALYTICAL RESULTS FOR WATER SAMPLES FROM
THE WELLGREEN PROJECT AREA - SITE: WG2

ANALYTICAL PARAMETER	AUG. 26/87
pH	7.5
Alkalinity (mg $CaCO_3$/L)	419
Turbidity (NTU)	170
Conductance (µmhos/cm)	980
Total Solids (mg/L)	2116
Suspended Solids (mg/L)	1330
EDTA-Hardness (mg $CaCO_3$/L)	542
Colour (Apha Units)	<10
Sulfate (mg/L)	241
Ammonia (mg N/L)	0.046
Nitrate (mg N/L)	<0.005
Nitrite (mg N/L)	<0.002
Total Phosphorus (mg P/L)	1.13
Total Cyanide (mg/L)	<0.001
Chloride (mg/L)	0.52
Calcium (mg/L)	210
Magnesium (mg/L)	28
Potassium (mg/L)	6.4
Sodium (mg/L)	6.9
TOTAL METALS: (mg/L)	
Ag	0.0003
Al	3.1
As	0.008
Ba	0.12
Cd	0.0007
Co	0.031
Cr	0.09
Cu	0.09
Fe	24.2
Hg (µg/L)	<0.05
Mn	1.11
Mo	<0.005
Ni	0.09
Pb	0.002
Sb	<0.002
Se	<0.001
Zn	0.09
DISSOLVED METALS: (mg/L)	
Ag	<0.0002
Al	0.11
As	0.001
Ba	0.052
Cd	<0.0002
Co	<0.001
Cr	0.005
Cu	0.0029
Fe	0.22
Mn	0.09
Mo	<0.005
Ni	0.004
Pb	<0.001
Sb	<0.002
Se	<0.001
Zn	0.0013

APPENDIX II
ANALYTICAL RESULTS FOR WATER SAMPLES FROM THE WELLGREEN PROJECT AREA - SITE: WG3

ANALYTICAL PARAMETER	AUG. 25/87
pH	7.7
Alkalinity (mg $CaCO_3$/L)	121
Turbidity (NTU)	27
Conductance (µmhos/cm)	215
Total Solids (mg/L)	767
Suspended Solids (mg/L)	323
EDTA-Hardness (mg $CaCO_3$/L)	125
Colour (Apha Units)	17
Sulfate (mg/L)	66
Ammonia (mg N/L)	<0.005
Nitrate (mg N/L)	0.136
Nitrite (mg N/L)	<0.002
Total Phosphorus (mg P/L)	0.255
Total Cyanide (mg/L)	<0.001
Chloride (mg/L)	0.22
Calcium (mg/L)	9.0
Magnesium (mg/L)	22
Potassium (mg/L)	0.39
Sodium (mg/L)	0.43
TOTAL METALS: (mg/L)	
Ag	<0.0002
Al	1.1
As	<0.001
Ba	0.015
Cd	<0.0002
Co	0.010
Cr	0.09
Cu	0.03
Fe	1.15
Hg (µg/L)	<0.05
Mn	0.05
Mo	<0.005
Ni	0.12
Pb	<0.001
Sb	<0.002
Se	0.001
Zn	0.0046
DISSOLVED METALS: (mg/L)	
Ag	<0.0002
Al	0.011
As	<0.001
Ba	0.013
Cd	<0.0002
Co	<0.001
Cr	0.023
Cu	0.0021
Fe	0.024
Mn	<0.001
Mo	<0.005
Ni	0.027
Pb	<0.001
Sb	<0.002
Se	0.001
Zn	<0.0005

APPENDIX II
ANALYTICAL RESULTS FOR WATER SAMPLES FROM THE WELLGREEN PROJECT AREA - SITE: WG4

ANALYTICAL PARAMETER	AUG. 25/87
pH	7.9
Alkalinity (mg $CaCO_3$/L)	106
Turbidity (NTU)	120
Conductance (µmhos/cm)	195
Total Solids (mg/L)	932
Suspended Solids (mg/L)	750
EDTA-Hardness (mg $CaCO_3$/L)	104
Color (Apha Units)	30
Sulfate (mg/L)	19
Ammonia (mg N/L)	0.009
Nitrate (mg N/L)	0.094
Nitrite (mg N/L)	<0.002
Total Phosphorus (mg P/L)	0.792
Total Cyanide (mg/L)	<0.001
Chloride (mg/L)	0.42
Calcium (mg/L)	32
Magnesium (mg/L)	6.0
Potassium (mg/L)	0.50
Sodium (mg/L)	1.4
TOTAL METALS: (mg/L)	
Ag	<0.0002
Al	1.7
As	0.035
Ba	0.047
Cd	<0.0002
Co	0.021
Cr	0.031
Cu	0.08
Fe	3.12
Hg (µg/L)	<0.05
Mn	0.12
Mo	<0.005
Ni	0.11
Pb	0.001
Sb	<0.002
Se	<0.001
Zn	0.0081
DISSOLVED METALS: (mg/L)	
Ag	<0.0002
Al	0.21
As	0.004
Ba	0.016
Cd	<0.0002
Co	<0.001
Cr	0.002
Cu	0.010
Fe	0.12
Mn	<0.001
Mo	<0.005
Ni	0.008
Pb	<0.001
Sb	<0.002
Se	<0.001
Zn	0.0010

APPENDIX II
ANALYTICAL RESULTS FOR WATER SAMPLES FROM THE WELLGREEN PROJECT AREA - SITE: WG5

ANALYTICAL PARAMETER	AUG. 25/87
pH	7.9
Alkalinity (mg $CaCO_3$/L)	206
Turbidity (NTU)	100
Conductance (µmhos/cm)	330
Total Solids (mg/L)	3841
Suspended Solids (mg/L)	3100
EDTA-Hardness (mg $CaCO_3$/L)	151
Color (Apha Units)	80
Sulfate (mg/L)	25
Ammonia (mg N/L)	0.030
Nitrate (mg N/L)	0.081
Nitrite (mg N/L)	<0.002
Total Phosphorus (mg P/L)	1.70
Total Cyanide (mg/L)	<0.001
Chloride (mg/L)	1.66
TOTAL METALS: (mg/L)	
Ag	
Al	
As	
Ba	
Cd	
Co	
Cr	
Cu	
Fe	
Hg (µg/L)	<0.05
Mn	
Mo	
Ni	
Pb	
Sb	
Se	
Zn	
DISSOLVED METALS: (mg/L)	
Ag	
Al	
As	
Ba	
Cd	
Co	
Cr	
Cu	
Fe	
Mn	
Mo	
Ni	
Pb	
Sb	
Se	
Zn	

APPENDIX II

WATER TEMPERATURES COLLECTED DURING WATER SAMPLING IN THE WELLGREEN PROJECT AREA IN 1987

SITE	TEMPERATURE (^{O}C)			
	JULY 2/87	AUGUST 26/87	OCTOBER 27/87	MARCH 15-16/88
S 1	16.5	13.0	0.5	N/S
S 4	5.5	5.0	0.0	N/S
S 5	4.5	4.0	0.0	0.0
S 6	6.5	6.0	N/S	N/S
S 7	3.5	4.5	0.5	N/S
S 8	4.0	5.5	0.0	N/S
S 9	4.0	5.5	0.0	N/S
S11	5.5	3.5	0.0	N/S
S12	11.0	12.0	1.0	3.0
S13	12.0	12.0	1.0	3.0
S14	12.0	N/S	N/S	N/S
S15	N/S	3.0	1.5	N/S
S16	N/S	N/S	N/S	1.0
S17	N/S	2.0	N/S	0.0
S18	N/S	N/S	N/S	4.0
A 1	N/S	2.0	2.0	3.5

* N/S - Not Sampled

APPENDIX III

AERIAL WILDLIFE SURVEYS IN THE WELLGREEN PROJECT AREA CONDUCTED AUGUST 26, 1987 AND MARCH 15,1988

(Pages 1-7)

NORECOL ENVIRONMENTAL CONSULTANTS LTD.
AERIAL WILDLIFE SURVEY REPORT
WELLGREEN PROPERTY, YUKON
August 26, 1987

TIME OF THE SURVEY: 1420 - 1443 hours

HELICOPTER: Trans North Air from Haines Junction base
Pilot: Doug Makkonen

OBSERVERS: Chris Schmidt, Norecol (front left)
Rick, Archer Cathro (rear left)
Cindy Ott, Norecol (rear right)

WEATHER: Cloud: 50% high overcast
Wind: light
Temperature: 8°C
Precipitation: light drizzle up high
Visibility: good

SNOW COVER: nil on south aspects, up to 50% average on upper north aspects

AREA SURVEYED: Mount Wellgreen, Aird Creek, ridges and tops to northwest of Mount Wellgreen, ridges and tops south and west of camp toward Donjek River.

OBSERVATIONS:

Dall's sheep	18
Caribou	4
Golden Eagles	2

NORECOL ENVIRONMENTAL CONSULTANTS LTD.
AERIAL WILDLIFE SURVEY REPORT
WELLGREEN PROPERTY, YUKON

August 26, 1987

Leaving camp at 1420 hours to check out the mineral exploration area and adjacent ridges. Weather is scattered high cloud, 50%, no precipitation within the past 72 hours. Some light rain at higher elevations. Visibility is good to excellent. Limited snow cover on the ground; ridge tops and north aspect upper slopes have up to 50% light snow cover. Four caribou on the mountain southwest of the camp, on rocky ridge above an access road (above one of the lakes). They were on a snow patch immediately below the ridge crest on the north aspect. Some caribou tracks just to the southwest of the sighting. One ram sheep on a lower rocky ridge at about 1676 m, good sized animal. Habitat was rock and talus with sparse vegetation. Over on Donjek River side of range, 1 sheep ewe on rocks at 1463 m above river floodplain; area has good forage and an abundance of escape terrain.

Heading eastwards of camp, across from the exploration area on south side of range. One Golden Eagle on rocky ridge crest over high alpine tundra, rock bluff habitat. Another Golden Eagle over Nickel Creek below the helicopter.

On north side of Nickel Creek, to the east of the exploration area. Fair bit of snow on north aspects on the north side of the valley. Fresh snow is up to 70% in some places. Starting to get sheep trails on the north side of Mount Wellgreen. 10 sheep at 1890 m, including several good sized rams plus at least one kid. This was on northeast aspect of rocky ridge, trending down slope. 2 rams on a mid elevation ridge at 1677 m running across slope. 2 rams silhouetted on ridge north of last sighting at 1890 m at ridge crest, overlooking the main valley below. This was fairly close to the Donjek side, north of the westernmost of the two lakes.

Now heading around the south aspect of ridge above the lakes and heading over to exploration area. 2 rams at 1860 m on rocky ridge crest, extremely steep in this area with sparse vegetation cover. There are several sheep trails in the area.

Heading toward Mt. Wellgreen on south aspect, there are more sheep trails up high. Lots of rock and talus into the exploration area on the south slope of Mount Wellgreen. On the upper ridges above the exploration work, there are several well used sheep trails along ridges crests and across talus slopes.

Above Aird Creek, checking out the ridge crests and slopes. Less sign of sheep activity in the Aird Creek basin.

Finished survey at 1443 hours. End of aerial survey. Headed over to peak immediately south of camp for drop off to do habitat checks and walk down to camp.

NORECOL ENVIRONMENTAL CONSULTANTS LTD.
AERIAL WILDLIFE SURVEY REPORT
WELLGREEN PROPERTY, YUKON
March 15, 1988

TIME OF SURVEY:	0930 - 1030
HELICOPTER:	Bell 206B Jet Ranger from Trans North Air in Whitehorse; C-FMBT; Pilot: Dave Logan
OBSERVERS:	Chris Schmidt, Norecol (front left) Goff Longworth, Norecol (rear left)
WEATHER:	Cloud: 70 - 80% Wind: calm Temperature: -10°C and warming Precipitation: nil in past 24 hours Visibility: excellent
SNOW COVER:	In valley bottoms and north aspects close to 100%. South aspects on slopes down to 20%; many steep grassland slopes and ridge crests are bare of snow. Snow depth 20 - 30 cm in valley bottom; 10 - 20 cm on slopes, higher in gullies.
AREA SURVEYED:	Mount Wellgreen, Aird Creek, ridges south of Nickel Creek toward Donjek River.
OBSERVATIONS:	Dall's sheep 53 Mountain goat 1 Ptarmigan 26+

NORECOL ENVIRONMENTAL CONSULTANTS LTD.
AERIAL WILDLIFE SURVEY
WELLGREEN PROPERTY, YUKON
March 15, 1988

Departing from Kluane Wilderness Lodge at 0930 on Bell 206B helicopter from Trans North Air out of Whitehorse, C-FMBT, pilot is Dave Logan. Observers on board were Chris Schmidt (from left) and Goff Longworth (rear left) from Norecol Environmental Consultants Ltd. Weather is cool, -10°C and warming. Calm with high overcast scattered cloud, 70-80%. No precipitation in past 24 hours. In Kluane valley, snow cover is close to 100%, except along Kluane River where there are some bare spots. Heading up Kluane River to Quill Creek and the up Quill Creek to Wellgreen Property.

At Mount Wellgreen at 0938 and starting search of property. Starting on lower slopes of Mount Wellgreen above valley floor and heading westward. Snow cover is 50% or less in many places. Only a shallow layer of snow at most. Lots of shrubs and forage are available. Snow cover is 100% in immediate valley bottom at Wellgreen camp. Snow is 70% plus on north-facing slopes above camp. Flew along contour westward to west Arch Creek (main tributary of Arch Creek on north side of valley), then to mid slope and heading eastward along contour to Mount Wellgreen. A group of <u>five sheep</u> above West Arch Creek, southwest aspect with rocky ridge, at 1730 m elevation.

Over Mount Wellgreen on exploration area, snow cover is down to 15% over much of mid slope; gullies have 25%. There are a lot of shrubs and grasses/forbs available on this slope. No sheep or sign of tracks on immediate exploration area on this slope of Mount Wellgreen.

On the large expanse of exploration area, there is ample available sheep winter range, with good aspect, steep escape terrain and lots of forage. Over adit area above Aird Creek. Once we are on northeast aspect in Aird Creek basin, snow cover increases to 80%, with much less forage available. On southeast or south aspect of basin, snow cover is down to 20 - 25%. Snow depth at mid slope is 20 cm at most; a bit deeper in gullies. Snow is not an impediment to sheep movements in the area at the present time and likely not for most of this winter.

Snow is blown off quickly by high winds coming through valley and on the southern exposures by solar radiation. Swinging around the east side of the Aird Creek basin to east edge of property. Three sheep (rams) high up on ridge at 1860 m above the adit area on east side of Aird Creek; running up toward ridge crest (200 m below crest where first spotted). Area was completely free of snow with good cover of forage.

On upper ridge for last westward swing of area. Along ridge crest from north of junction of Nickel and Quill creeks. On ridge crest, snow is down to 15% where aspect is southerly; some forage available but sparser than on lower slopes. Twenty sheep on ridge crest on east side of Aird Creek basin at 1980 m. Mostly rams. They were single file on ridge crest and moved northwesterly along crest; very rugged terrain. Now on highest ridge crest of Aird Creek basin. Good sheep range. North aspect on other side of ridge crest has much higher snow cover. The ridge complexes to the north of Mount Wellgreen have considerable suitable sheep range - snow cover is also reduced on many of these ridges and they have good escape terrain.

Searching ridge tops immediately north of Wellgreen camp. There are eight sheep (ewes and yearlings), fairly close to ridge crest at 2010 m in an area that is almost free of snow; very rugged. Next basin to west of camp has good sheep range; open and rugged though forage is not as abundant as on lower slopes. Now in basin of creek immediately to the west of the twin ponds, there is a ram sheep standing on ridge crest at 1980 m. Sweeping large basin of West Arch Creek. Six sheep at at upper, western exposed basin of West Arch creek at 1920 m - aspect faces Donjek valley, 50 m below ridge crest on steep, grassy slope. Snow cover 20% or less. Five sheep at middle of large basin, plus one sheep just below ridge crest, both near 1980 m. This is a very large basin with good sheep range. Tracks evident on upper slopes. Good escape terrain and it is largely free of snow. Forage availability is good from lower to upper slopes.

Over on west aspect slopes above Donjek River, south of Arch Creek, to do a quick search of the bluffs here for sheep and goats. Very steep and rocky, little snow down to 5%. Good escape terrain and good food availability. One goat about half way up slope (1340 m) on rock bluffs; snow less than 2%.

Heading back up Arch Creek to Wellgreen camp area. Searching ridge tops south of Arch - Nickel creeks (corresponding to area searched in August 1987). Some exposed slopes on south aspect. Some forage available on ridge crests. In basin above western pond. Six ptarmigan on slope below us. Very rocky on this side of valley and forage availability is less than on north side of valley. Another large flock of 20 - 30 ptarmigan on upper slope, flushed by helicopter. Four sheep (rams) on ridge crest at 1675 m immediately opposite of Aird Creek; saw their tracks on ridge first. Escape terrain was not as steep and rugged in this area as rest of area searched. Finished at 1025 with sheep survey and headed to hydrology and water sample station on Arch Creek. Abundant moose tracks on valley bottom between two ponds and down Arch Creek. Some recent tracks crossing willow flats, and also down across road heading down Arch Creek. Possibly one moose in area.

End of survey at 10:30.